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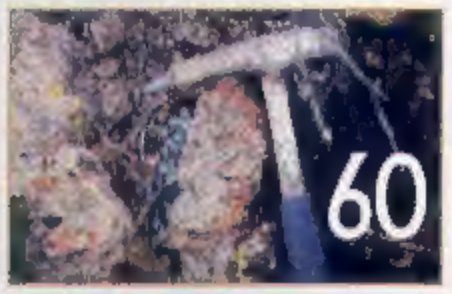

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ON THE COVER

Rock & Gem turns the spotlight on gold. This stunning 18.5-centimeter-high specimen from the Colorado Quartz Mine in Mariposa County, California, resides in the Houston Museum of Natural Science. (Photo by Jeff Scovil)

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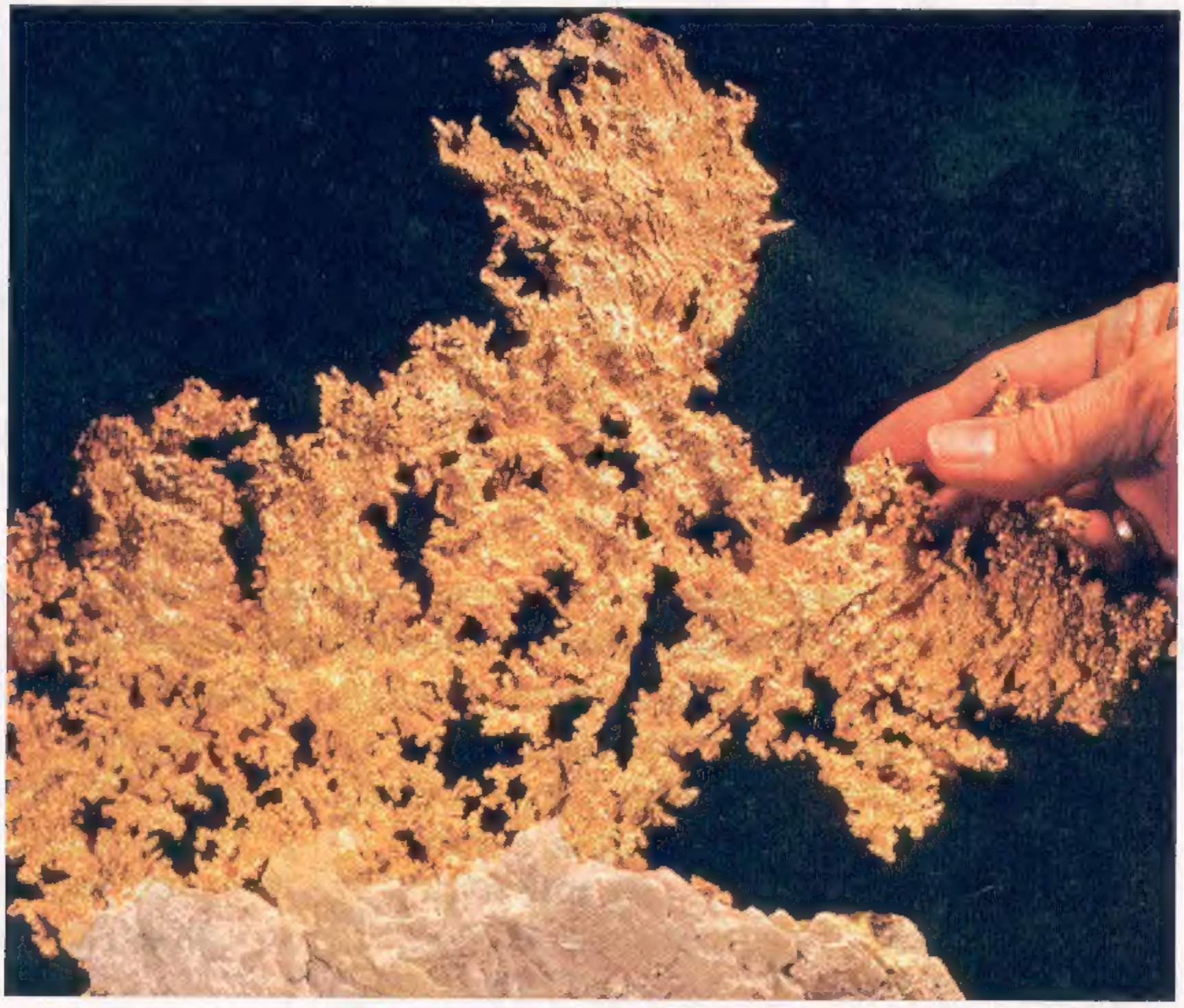
The Language of GOLD

There's a Word for Every Characteristic

Story and Photos by Bob Jones



This magnificent dendritic gold specimen lacks visible crystals, its intergrown masses resembling a flattened dendrite.

It has been called *sol, aurum, or,* and *oro,* but in our language it is called gold, from the German word *guld.* Because gold is found in a wonderful variety of forms, we have developed a compendium of names to help distinguish one from the other.

There is also a terminology attached to the efforts to extract gold from the earth. Humans through the ages have developed an assortment of tools, equipment, chemicals, and machines to extract the yellow metal from the confines of Earth's rocks. These names give us a good idea of how gold has been recovered in the past, and how that effort has evolved to modern times.

Over 1,000 years ago, alchemists tried to transmute substances like lead into the yellow metal. They unknowingly discovered a chemical that was to be used later to extract gold! Alchemists talked about recovering *sol,* which they represented with a circle with a dot in its center. This symbol was also used to define divinity and perfection in all things. It doesn't take much imagination to see that the circle represents the sun. Today, the symbol for gold is Au, derived from the Latin word *aurum.*

If you look into the use of gold by the ancient Egyptians, you find their eager

search for and abundant use of gold was not motivated by the desire for wealth as much as for the desire to find the perfection and divinity of their sun god. They considered gold to be the "flesh of the gods," and using it for funerary décor was an attempt to associate the dead with the gods.

The Egyptians mined some of their gold in a land they called Nubia, their word for gold. The bulk of their gold came from hardrock mining, with most mines located in a dry riverbed area called Wadi Mammamat. We know this because the Egyptians actually left us a map to the mines.

The Egyptians also developed some of the mining techniques still in use a couple thousand years later. Realizing that gold was heavy, they used slaves, usually women and children, to mine the auriferous (gold-bearing) rock, carry it to the surface in baskets, and crush it to a fine powder. The crushed rock was then spread over a flat rock with a deeply grooved surface. Water washed the crushed rock over these grooves, which caught the heavier gold as the water carried away the waste rock.

America's '49ers used this same basic technique when they put riffles on the bottom of a long trough and flushed gold-bearing sand and gravel through it. Sometimes, the '49ers used carpeting instead of wooden bars. The use of carpeting hearkens back to the legend of Jason and the Argonauts, who sought the golden fleece, a sheepskin used to catch gold in fast-running water.

The Egyptians also developed a simple gold smelting technique that yielded fairly pure metal. They put the crushed gold-bearing rock, wheat chaff, and mineral salts in a clay pot, sealed it, and fired it. A small gold button would result. Today, we use this same basic technique to assay a gold ore sample, but using different chemicals.

PALA INTERNATIONAL, FALLBROOK, CA

These hoppered gold crystals are also autoepitaxial, since each crystal has oriented itself in a regular pattern on another crystal.

Gold that develops a spongelike structure full of small open spaces is called spongeform.

Gold forms in the isometric or cubic system, yet simple cubes of natural gold are extremely rare. And even when gold does develop a cubelike form, the six flat faces are seldom complete. More often, they have depressions in the center of each face. This happens because, as the cube develops, the gold atoms tend to stack more rapidly along the edges of the cube. As the supply of gold atoms in the solution diminishes, the faces outlined by those fast-growing edges grow less quickly or, when the gold atoms are all used up in the solution, remain unfilled. We say such a crystal is "hoppered."

Another term we use frequently with gold is "skeletal." As gold crystals form and the supply of gold is sparse, thin rods of the metal develop, but never fill in, so a framework not unlike a skeleton without flesh results. These can be quite attractive and make nice collector specimens.

Of course, so much natural gold is found in rounded masses that the term "nugget" is widely applied. A nugget is any more or less rounded mass of anything. In the case of gold, nuggets result when gold that has been released from its enclosing rock is repeatedly squeezed, pounded and rolled by natural forces until whatever crystal form or faces it may have had are completely obliterated. Only gold's tenacity and malleability keeps the free gold together. "Malleability" is the property of being able to be hammered into a shape or sheet without breaking or cracking. For example, you can hammer an ounce of gold into a sheet so thin that light will pass through it. The thin gold takes on a greenish hue. Such a sheet is only $^{1}/_{200,000,000}$ inch thick, yet it will not crack. You can stack 350,000 such sheets, and the pile will still be less than an inch high!

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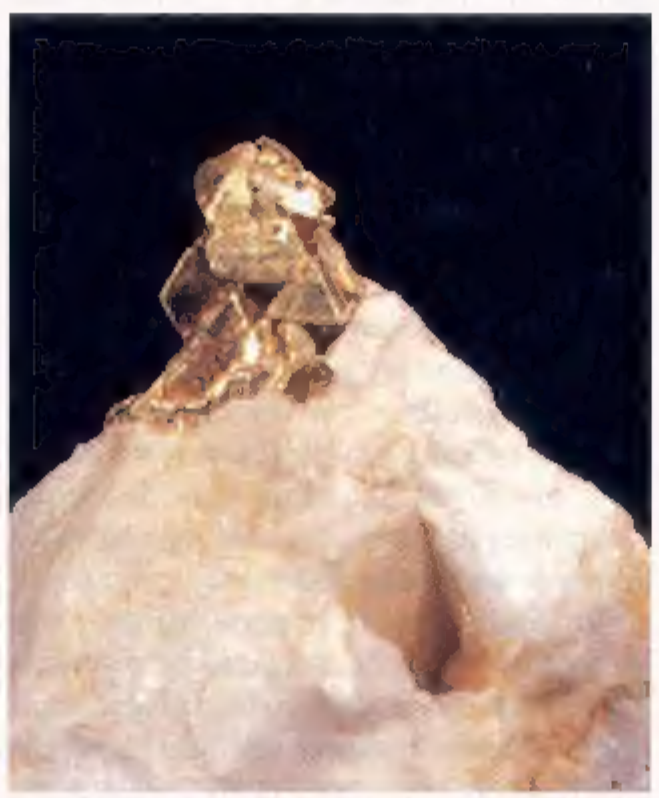
This ribbon, or leaf, gold is also tesselated, meaning the leaf surfaces have small growth patterns visible on them.



The Princeton Mine in California produced half-inch octahedrons of gold on quartz.

A combination of platy gold with small octahedrons and trigons give this superb specimen a three-dimensional shape.

It's when gold develops in free form that it can actually develop in crystals. Because of the variety of such forms, we have some confusion in terminology. What is the difference between a filiform and reticulated gold? Between dendritic and skeletal gold? Or how about ferm and leaf gold? And is filigree gold different from tesselated gold?

As noted, gold rarely forms in cubes. Much more common—if you can use the term common when referring to any gold—are octahedrons of gold. An octahedron is a crystal that looks like two pyramids base to base. Eight faces make up the crystal, and the faces may be hoppered. Stacking a series of octahedral shapes one on the other brings about the term castellated, as the edges resemble the parapet of a castle. Another term that can be applied here is "oriented overgrowths," or "intergrowths," if the crystals are distinct enough.

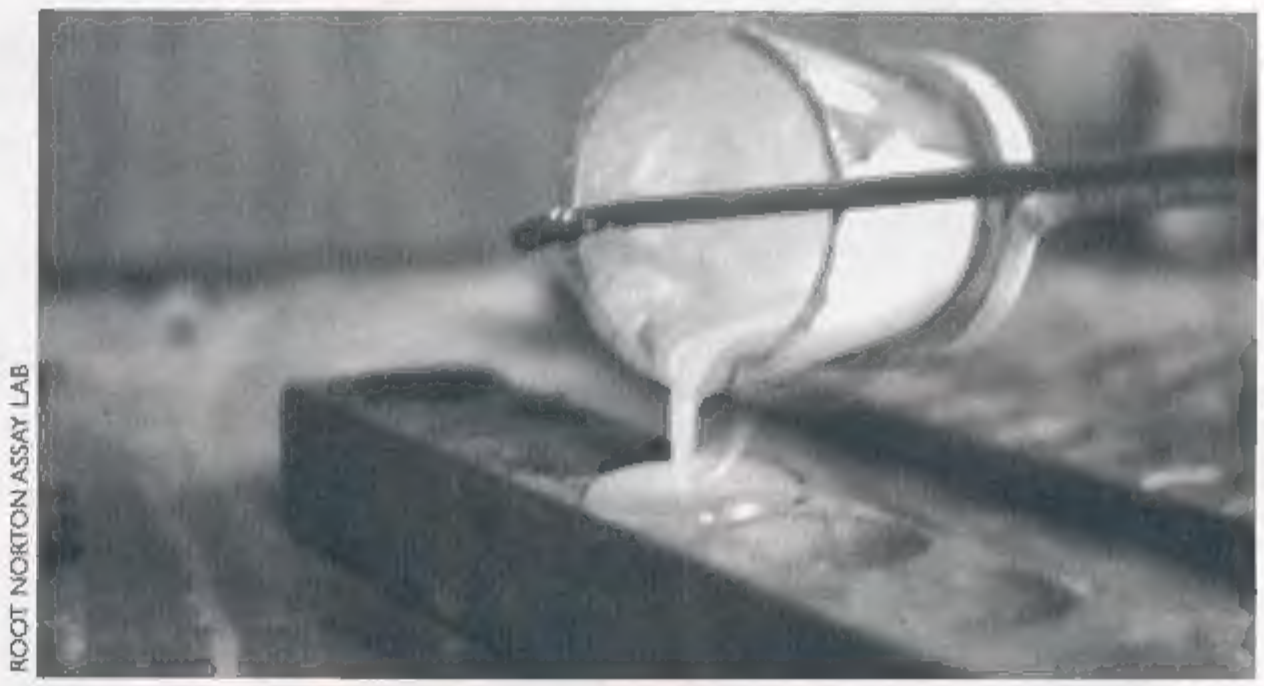
Another fairly common form of gold starts out as an octahedron, but the six corners flatten out, creating another set of six faces, so the crystal has a total of 12 faces. We call such a crystal a rhombic dodecahedron. "Rhombic" refers to the shape of the faces, while "dodecahedron" is a simple numerical name: "do-" equals two, "deca-" equals 10, and "-hedron" equals shape. Hence, two plus 10 equals a crystal shape having 12 faces.

Gold is often found in sheetlike shapes, usually curved, which we often call leaf gold. But as bright as these natural platy leaves of gold are, they are seldom smooth-surfaced. Instead, they are checked and patterned with triangular shapes we call trigons, another term for triangles. On those same flat leaves of gold, there may be growth lines, grooves, and other growth imperfections, so we use the term "tessellated" as an all-inclusive descriptive term. When several leaves of gold develop one on another in a stacked or interlocking form, we refer to the overall shape as "lamellar."

So gold can develop in any one of several crystal forms. More often than not, the crystal form is not perfect. It may be rounded, as if worn by the tumbling action in flowing water, or it may be stretched, flattened, or otherwise flawed. We refer to such misshapen crystals as being "distorted" or "deformed." If the crystal form is easily distinguished, but stretched in a given direction, we usually say the crystal is "elongate."

One of the most commonly used terms for gold is "dendritic," from the Greek root word for tree. Any mineral that forms treelike, branching shapes is said to be dendritic. Those of you who have collected agates containing branching manganese oxide crystals refer to them as dendritic agate. The crystal growth of the manganese dendrites is restricted, since the enclosing quartz allows them to grow in only two directions. Gold, on the other hand, can often develop three-dimensional dendritic form in the open spaces of the host rock.

Dendritic gold follows very definite mathematical patterns. The cluster starts out as a single crystal, then develops branches, which grow away from the initial crystal in any direction. The branching gold will grow at either a 60-degree or 90-degree angle from the base crystal. These ensuing crystals will, in turn, develop additional branches, again at 60 or 90 degrees. This process continues until the supply of gold atoms is depleted. In exceptional cases where space allows, this creates a superb three-dimensional, multibranched dendritic crystal specimen that is highly sought after. Such crystal groups are thought to have grown very rapidly. It is generally agreed that dendritic gold specimens are among the more valuable specimens available.



ROOT NORTON ASSAY LAB

Gold assaying today is not much different from the technique developed by the ancient Egyptians.

The reason dendritic gold forms is easily explained. Ascending solutions, from which it forms, are not particularly loaded with gold. As this hot, gold-bearing solution ascends, it encounters descending, cooler surface waters. This sudden change in temperature forces the gold to crystallize very rapidly, so myriad small crystals grow, which explains the lack of larger, euhedral gold crystals. Dendritic gold crystals are sometimes visible only with magnification.

One of the more unusual forms seen in gold is called "autoepitaxy." Epitaxy is the term given to crystals that orient themselves on existing crystals in a parallel manner. Epitaxial growth is usually between two different mineral species, but gold is capable of developing epitaxial growth on itself, hence the term autoepitaxy. Dendritic gold sometimes shows autoepitaxial growth.

Dendritic gold is the most popular form of collector gold because of its organized and aesthetic forms. Resembling as it does the natural shape of living things, gold dendrite specimens touch not only our love of the metal itself, but our aesthetic appreciation of the natural form it has. A delicate, treelike gold dendrite emerging regally from a piece of rock is truly a thing of exquisite beauty.

Similar to dendritic gold is "filigree" gold. The circumstances of formation are probably the same. The difference is that filigree gold shows no mathematical relationship between the initial crystal and the succeeding branches. In this case, the gold crystals are simply attached to each other in an open framework. You've undoubtedly seen the filigree technique used by artists in the making of delicate jewelry. Artists emulate the process that occurs naturally with thin gold wires.

Sometimes, when gold forms enclosed in quartz, it does not develop visible crystals. Instead, the gold develops a honeycomb or spongelike structure full of small open spaces. We give such gold the obvious name "spongeform." If the gold in such a state is extremely fine or threadlike, we call it "filiform" gold, based on the word filament.

No matter what form gold takes, its inherent bright luster and superb color makes it the most sought after native metal whose existence has been revered from earliest times until today!

Just as gold was given a variety of names throughout history, so, too, were the techniques for its recovery. The simplest method for finding and collecting gold was to pick it up from where it had

eroded from its host rock. When this loose gold is collected found in flowing streams, we call the recovery "placering."

Placering can take many forms. The legend of Jason and the Argonauts is based on the fact that gold placering was achieved in the region of Colchis in Southwest Asia. Locals put sheepskins along the bottom of creeks when spring freshets rushed from the highlands carrying sand and gravel, including gold flakes. The sticky lanolin-coated sheepskin would trap the flakes, turning wool into a glittering golden fleece!

More practical placering is achieved in several ways. The earlier methods used a shallow bowl or pan to separate gold from the stream sands. The pan was eventually replaced by wooden devices called rockers or sluices.

mercury could be re-captured by cooling and used again and again.

The most destructive use of water in gold mining is to force gold-bearing gravels through a separation method, a technique we call hydraulicking! Using the force of flowing water, sand and gravel is torn loose and washed into a device for recovering the gold. The term hydraulicking immediately reminds us of the vast destruction this method caused in California in the 19th century. It got so bad that the state finally passed laws to prevent the sand and gravel waste from being dumped downstream and clogging the water channels.

The natural assumption is that hydraulicking was invented in California. Not so! When the Romans invaded Spain to obtain its vast deposits of gold and sil-

A team of miners uses a Long Tom to recover gold from California placers.

The rocker was a two-man operation; one fellow shoveled stream gravels into the top of the rocker and the other rocked the wooden box back and forth to stir the gravel as water carried it along the sloping box. This encouraged any gold present in the gravel to settle to the bottom of the sluice, where it would be trapped by wooden strips placed crossways in the sluice box.

A larger version of the sluice box was the Long Tom; it could be 20 to 100 or more feet long, but it operated on the same principal. Several partners could do the shoveling, which, at least in theory, would increase the "take."

An improvement on the sluice happened when puddles of mercury were put behind the wooden strips in the bottom of the sluice. Since gold has an affinity for mercury and readily forms an amalgam with it, the puddles of mercury would facilitate the capture of the fine gold. Later, the gold-mercury amalgam could be separated by boiling off the mercury. Released as a vapor, the

ver, one of the most important techniques they used to mine gold was hydraulicking. Granted, they did not use high-pressure water cannons. They built dams high in the mountains, which held back huge volumes of water. This water was then released to surge along a channel, often stone viaducts. The rushing water would tear down entire hillsides, and the sand and gravel was run through huge sluices. This not only produced gold much faster, but required fewer people to do it.

Once placering exhausted the available alluvial gold that nature had released from its host rock, hardrock mining techniques had to be developed. Again, the Egyptians led the way.

Crushing rock by hand to release gold not only requires huge numbers of people, usually slaves, but is very wasteful, seldom recovering more than a third of the gold content in the rock! As mining evolved, so did crushing and recovery methods.

continued on next page

The Language of Gold *from page 15*

The simplest way to crush rock is by using a drag stone. A confined space on a hard rock floor kept the gold ore in place. Then a heavy stone was dragged over the gold-bearing rock to crush it. Humans probably pulled the first drag stone, which became known as the arrastra, but horses and mules soon became the favored source of power.

The problem with an arrastra is the friction of the drag stone, which requires great deal of power to keep it moving over the ore. Someone figured out that if the drag stone could be made to roll, like a millstone used to produce flour, it would be more efficient. The Chilean Wheel was the result of this brainstorm.

With the advent of steam power adapted to machinery, it wasn't long before a powered method of crushing ore was developed. It consisted of lifting and dropping heavy blocks of iron, called shoes or stamps, on the gold ore to crush it into a flourlike consistency. These machines, called stamp mills, were built on a slope, usually a hillside near the mine. Gravity was used to "feed" the ore into stamp mill for crushing. The partially crushed ore would tumble under the stamps, where they were crushed to a fine powder. Water was used to carry away the particles, including the gold, so it could be separated out.

The next obvious problem was extracting the gold from the crushed rock more efficiently. Initially, the rock was run through a sluicelike device, but engineers already knew that mercury was more effective in catching fine gold flakes. So, they ran the water carrying the flourlike crushed rock over a sheet of copper that was coated with native mercury. The mercury caught 60 or 70 percent of the gold, and was much more efficient than sluicing.

Like every mining method, this method had its negative side. Some of the mercury would escape in the flowing water and end up downstream. The stamp mills themselves required huge quantities of fuel for making steam, so the surrounding countryside was soon denuded of trees. And stamp mills made a deafening sound.

Today, the stamp mills are silent. We no longer use mercury to capture gold. We still use metal against metal to crush gold ore, but we almost quietly tumble the partially crushed rock in a barrellike machine. The tumbling mill contains either long steel rods or steel balls and water. As the huge steel drum rolls, the collision of rods or balls and rock accomplishes the crushing action once done by noisy stamp mills. We call these crushing machines ball mills or rod mills.

Just before dumping the resulting slurry into a deep trough, a small amount of oil is introduced into the mill. In the trough, pine oil and a small amount of acid are added. The pine oil, along with air introduced into the bottom of the flotation tank, creates a heavy froth of bubbles. The acid etches the surface of the metallic particles, helping them cling to the bubbles in the oily, soapy solution. The metal-bearing bubbles float off over the sides of the trough, while the waste rock particles sink to the bottom of the trough. Then the oily solution is dried into a gray cake that is mainly gold particles. This is now ready for smelting and recovery of the gold. These flotation tanks are used to capture a variety of metallic minerals, from gold to silver to copper to a whole series of sulfides that are later smelted to extract their metals.

Hydraulicking for gold, one of the most destructive mining techniques used, is now outlawed.

Another process for recovering gold hearkens back to the early days of silver mining in Germany. Discovered around 1000 A.D., German silver deposits were rich in the white metal and its compounds, called silver salts. Germans are great experimenters, and as Europe emerged from the Dark Ages, alchemists emerged as a significant force in the pseudosciences. Though many were charlatans, the alchemists did discover some useful things, one of which is called aqua regia, or "royal water." A mixture of hydrochloric acid and sulfuric acid, it can dissolve precious metals like gold and silver; gold is almost totally impervious to any other chemical action. Chemists in later decades discovered the chlorine in the hydrochloric acid was the active ingredient, and developed the chlorination process of gold extraction.

The problem with the chlorination process is that chlorine gas is deadly! The chlorination process had to be performed in a strong, sealed metal reaction tank. This really complicated the recovery of the gold, as well as cleaning up the mess. These negative factors caused engineers to look elsewhere for an efficient gold extraction process.

Enter the cyanidation process. This lethal but extremely effective gold extraction process was developed in the South Africa goldfields, where the gold is primarily microscopic flecks scattered randomly in the host rock. This gold ore is so lean that any ordinary gold recovery method will simply not be cost effective. In addition, the mines are operating as deep as 5,000 feet down and are so hot they have to be air-conditioned, so any recovery method has to be very efficient.

Careful experimentation led scientists of the Rand goldfields to develop a method of using cyanide, a compound of either calcium or sodium combined with carbon and nitrogen. Introduced into a gold-rich slurry, the cyanide locks onto the gold particles, separating the gold from the rock particles. However, the gold has to be released from the cyanide. This happens to be quite simple. Scientists found that sprinkling inexpensive powdered zinc into the gold-rich cyanide solution would precipitate the gold. The zinc grabs the cyanide, and the gold settles out in almost pure form.

The obvious problem with this process is the cyanide, a violent poison in any form, gas or liquid. Environmentalists cringe and howl when they hear of a mine using the cyanide process. After all, accidents can happen. One such accident happened in Romania in February 2000, when the cyanide "pond" of a gold mine broke through its barrier and poured into the Danube River, killing fish and other life in the river for several tens of miles! Still, if carefully controlled, the cyanide process can recover nearly 100 percent of the gold mined, and is the most efficient way to capture gold. It is now the chosen method at most gold mines.

As long as civilization progresses, mining and metal extraction will be with us, as our needs will only increase. Gold has even become a vital industrial metal. Fortunately, our understanding of the environment and its preservation has gained favor, so we will continue to mine and recover metals, but in a much more earth-friendly way.

SHOP TALK

by William A. Kappele

Odds and Ends

In a column a while back, I answered a reader's question about avoiding or getting rid of that annoying flat spot on a cab. Robert Heim of Decatur, Illinois, sent me an e-mail with another idea for solving this problem. Robert suggests that, after the preforming, you should cover the stone with a contrasting color of ink from a felt pen or a coat of paint from a spray can. When the paint or ink is gone, the flat spot will be, too.

Robert added this suggestion for making life more comfortable in the shop. Standing on a concrete floor can be very hard on the feet and legs after a while. Robert's suggestion is to cover your concrete floor with carpet—an old piece you've replaced or a remnant obtained from your local carpet dealer. The trick, he says, is to install it upside down. This way, you won't lose that tiny cab or other small pieces in the nap of the carpet.

When I read this e-mail, I had another idea. Recently, a lot of the big auto parts chains in our area have been advertising 2-foot by 2-foot interlocking rubber mats for use on concrete garage floors. They are relatively cheap and should work great for keeping our lapidary feet and legs a little more comfortable.

I found this tip while surfing the Internet. If you use plastic pellets in the various stages of tumbling, wash them thoroughly after every use and keep them in plastic Ziploc-type bags, carefully labeled with the grit they were used with. This saves the cost of buying new pellets all the time, and prevents the possibility of getting a coarse grit in your polish stage.

I've mentioned using those little two-way FRS radios on field trips. If your shop is down in the basement, out in the garage, or in a separate building, you can also use them to get a call to dinner or to be alerted that a rerun of "Starsky and Hutch" is starting.

Not long ago, I was contacted about how to make and tune wind chimes. In our hobby, wind chimes are most commonly made from thin agate (usually Brazilian) slices. A small hole is drilled in the end, or a bell cap is epoxied on. The slices are then suspended from a platform so that they will bump together in the breeze. This produces a sound that will either sooth you or

drive you nuts. The subject of tuning is a whole other thing, however. Most wind chimes are made of steel, copper or aluminum tubing or bars. The matter of tuning is pretty much the application of a mathematical formula. With agate slices, the task is left to your ear.

There is a very good site on the Internet with information on making wind chimes from obsidian slices or scraps of stained glass. The address is www.sliceobisbee.com/SG/GlassWindChimes.html. Several other sites for wind chime makers are www.geocities.com/teeley2/chimeart.html, www.metalwebnews.com/howto/wchime/wchime.html, www.hgtv.com/hgtv/ah_moneysaving_recycle/article/0,1801,HGTV_3131_1398213,00.html, and http://groups.yahoo.com/group/windchimeconstruction/.

Something that most of us have problems with from time to time is rust. There is an old saying that refers to car bodies: Rust never sleeps. I, for one, believe it. The amount of rust will be in large part determined by the humidity in your area, where your equipment is located, and the type of coolant you use. In any case, it is a good idea to coat your rust-prone equipment with some form of rust inhibitor when you don't plan on using it for a while. There is an amazing array of products on the market, but one I have had very good luck with is Boeshield T-9. This stuff was developed by Boeing for protection of aircraft parts. If you have a rust problem, give it a try.

Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappelle@cox.net, or write to me at 25231 Pericia Dr., Mission Viejo, CA 92691.

THE GOLD RUSH GALLERY

Specimens and Artifacts from 17 States

Story and Photos by Steve Voynick

Colorado is well represented with specimens, including four nuggets from the Fairplay placers, in the Gold Rush Room.

This ¼-inch gold nugget from the Nacoochee placers in White County is part of the Georgia gold-rush exhibit.

As well as the American gold rush exhibits, the Gold Rush Room exhibits specimens like this 25-troy-ounce nugget from the Klondike Mining District in Canada's Yukon Territory.

Gold rushes have always occupied a special place in American history, and for a variety of reasons.

"They represent the very appealing elements of romance, adventure, individualism, and free enterprise," says Sam McGeorge, President and Executive Director of the National Mining Hall of Fame & Museum in Leadville, Colorado. "Furthermore, their profound impact on frontier expansion made them a symbol of the spirit of 19th-century America."

McGeorge is also curator of the museum's Gold Rush Room, whose exhibits include a broad variety of gold-rush artifacts, along with 100 individual specimens of gold ranging from 25-troy-ounce nuggets and crystallized masses to delicate examples of leaf and wire gold and cut-and-polished sections of bonanza-grade gold-in-quartz ores.

"Many people associate gold rushes only with such states as California, Colorado, South Dakota, and Alaska," notes McGeorge, a geological engineer and former superintendent of ASARCO's Black Cloud Mine, Colorado's last major multimetal mine, which produced lead, zinc, silver, and 10,000 troy ounces of gold per year. "But 17 states across the country have actually hosted historically significant rushes, a fact that reflects the broad geographical extent and impact of American gold mining. And here at the National Mining Hall of Fame & Museum, our Gold Rush Room displays gold specimens and gold-mining artifacts from each of these states."

The Gold Rush Room dates back nearly to the founding of the National Mining Hall of Fame & Museum. This museum, one of the nation's youngest, received its national charter from Congress in 1987. Shortly afterward, museum board chairman Dick Moolick, a geological engineer and retired Phelps Dodge Corp. president, got together with Carl Miller, one of the museum's first presidents, to develop a major gold-oriented attraction.

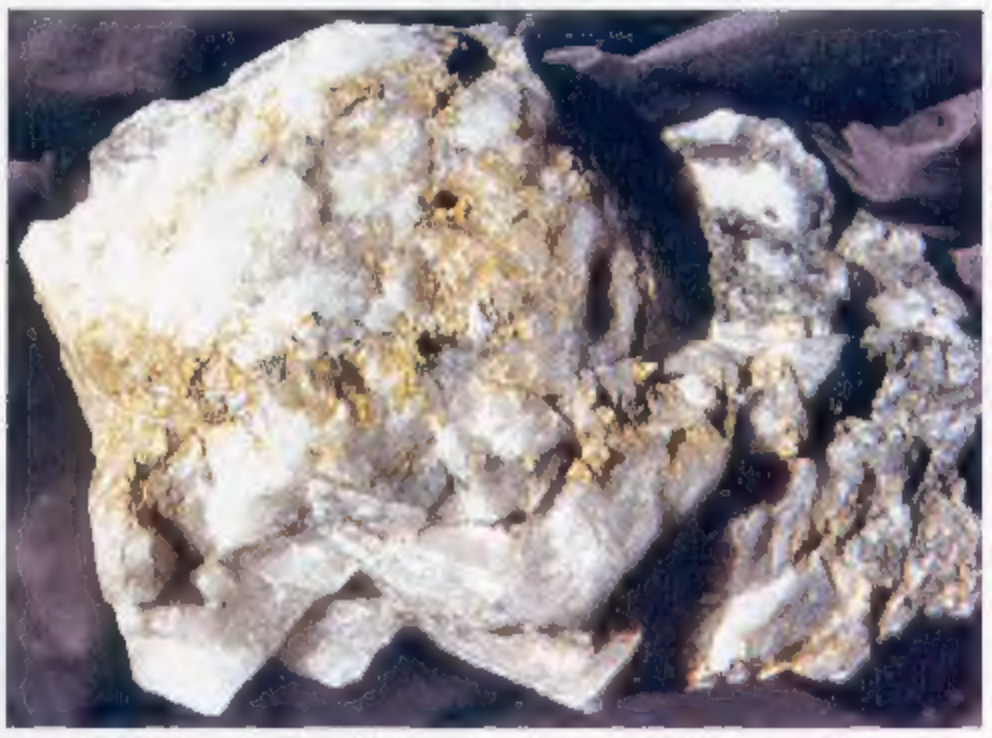
Miller, a former molybdenum miner and later a Colorado state legislator, suggested an exhibit of national interest that would present gold from both mineralogical and historical perspectives. They arrived at a theme when their research revealed that, although 17 states had hosted historically significant gold rushes, no museum in the nation had exhibits representing each of these states.

Acquiring specimens, historical photographs, and mining artifacts from these gold-rush states took two years. When the job was done, exhibit materials had been provided by more than 40 sources, including the Harvard Mineralogical Museum, the National Museum of Natural History (Smithsonian Institution), and the County Museum of Los Angeles, along with state and local museums, university libraries, state historical societies, mining companies, and individuals.

Today, some 250,000 visitors have explored the 19th-century American experience with gold through the exhibits at the Gold Rush Room. Each state exhibit features gold specimens, historical photographs, and such artifacts as gold balances, assayers' crucibles and cupels, gold pans and panning horns, hand steels, blasting equipment, miners' lamps, sconces, and stock certificates of long-defunct gold-mining companies.

The American adventure with gold actually predates the 19th century. In the 1500s, Spanish explorers searched for gold in the South and Southwest, just as English settlers in the 1600s searched for it along the Atlantic seaboard.

A 24.4-troy-ounce piece of crystallized gold represents the Little Johnny Mine in the Leadville Mining District.



An 8-inch specimen of high-grade gold in quartz from the Homestake Mine is part of the South Dakota exhibit in the Gold Rush Room.

By the early 1700s, colonial prospectors had discovered placer gold in the southern Appalachians, while by 1775, the Spanish had begun mining small amounts of the yellow metal in what is now Southern California. Then in 1787, prospectors near Fredricksburg, Virginia, found a 4-pound rock containing 1 troy ounce of gold, a discovery documented by none other than Thomas Jefferson.

Chronologically, the National Mining Hall of Fame & Museum's state-by-state gold-rush displays begin with **North Carolina,** where a 17-pound nugget was found in 1799. In 1803, the belated identification of this nugget started the first American gold rush. By 1810, North Carolina mines had produced some 135,000 troy ounces of gold—an amount several times greater than all that mined in the Southeast during the previous century. North Carolina is represented in the Gold Rush Room by a 2-inch specimen of gold in quartz and a 3-inch piece of wire gold on limonite matrix, both from Concord in Cabarrus County, not far from the famed Reed Gold Mine.

In the late 1820s, a string of discoveries triggered gold rushes in **Virginia, South Carolina,** and **Georgia.** Although Virginia began mining gold in 1806, production peaked in 1828 only after prospectors made new strikes in Spotsylvania, Orange and Fluvanna counties. Simultaneously, gold strikes in South Carolina set off rushes that led to development of the Haile, Brewer and Dorn mines on deposits that would be successfully reworked in the 1990s. Meanwhile, Georgia miners were rushing to strikes on the Dahlonega Gold Belt in White and Lumpkin counties.

By 1840, the cumulative gold production of Virginia, the Carolinas, and Georgia had topped 300,000 troy ounces and the U.S. Treasury Department had built two branch mints in North Carolina and Georgia. This southeastern gold-rush legacy is represented in the Gold Rush Room by a 3-inch piece of crystallized gold on quartz from Culpepper County, Virginia, and two specimens from Georgia, one a nugget from the Nacoochee Placers in White County and the other an unusual gold on bornite from the Dahlonega District in Lumpkin County.

Coinciding with the 1828 southeastern gold rushes was another near what is now Cerrillos, **New Mexico.** By 1833, miners, most from the Republic of Mexico, had washed out 100,000 troy ounces of gold from the discovery gravels of the Old Placers District. New Mexico's exhibit includes a 2-inch, gold-in-quartz specimen and a superb, 1-inch piece of crystallized gold from the nearby New Placers District.

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"After the rushes in the East and New Mexico, the next was to **California,**" McGeorge explains. "California opened a new era in America's experience with gold, both in the magnitude of production and the scale of the subsequent social, demographic, economic, and political impacts.

"California initiated a rapid succession of Western discoveries that revised our basic concept of gold," McGeorge continues. "Western gold occurred in much larger deposits and with a broader morphology than it did in the East. Placer miners found much larger nuggets, while hardrock miners encountered spectacular examples of crystallized gold and gold in quartz. And the specimens in our exhibits reflect this."

A half million Americans participated in the California gold rush of 1849. In eight years, countless mines along the 150-mile-long Mother Lode yielded 20 million troy ounces of gold—some 20 times more than had been mined in what is now the United States over the previous 150 years.

Among the California specimens in the Gold Rush Room are a large, cut and polished slab of gold-laced quartz, a 1-inch piece of bright crystallized gold, and an unusual, 3-inch specimen of native gold on terminated quartz crystals, all from the Empire Mine in Grass Valley. Other specimens include a 5-inch piece of high-grade gold in quartz from Amador County, gold in roscoelite (hydrous potassium vanadium aluminum silicate) from Coloma, and a beautiful, cut and polished 8-inch slab of gold in quartz from the Homestake Mining Co.'s McLaughlin Mine at Lone Tree. Also displayed are four examples of gold octahedrons on quartz and a collection of crystallized gold from Mariposa, Calaveras and Placer counties.

"The California experience greatly boosted the confidence of prospectors in their ability to find more gold," says McGeorge. "As the California rush subsided, thousands of prospectors fanned out across the West looking for that 'next California.'"

In the early 1850s, prospectors struck gold in Gold Canyon on a Carson River tributary in **Nevada.** Then the 1859 discovery of the rich Ophir diggings triggered the "Washoe Rush" and the subsequent find of the fabulously rich, silver-gold Comstock Lode near the future site of Virginia City. Later, in 1902, miners rushed to a new strike at Goldfield, Nevada. Among Nevada's specimens in the Gold Rush Room are a piece of gold in quartz from the Shamrock Mine in the Union Mining District and a 2-inch mass of crystallized gold from the Winnemucca Mining District.

In 1858, a minor discovery near the future site of Denver sent 50,000 gold-seekers rushing to the Pikes Peak country in what is now **Colorado.** Fortunately for these "'59ers," a series of rich strikes in the Rockies west of Denver the following year led to the founding of the boomtowns of Central City, Black Hawk, Idaho Springs, Fairplay, and Breckenridge. By 1867, Colorado's mines had yielded 1.3 million troy ounces of gold. Colorado's gold prospectors would later discover enormous deposits of silver, lead, molybdenum, and zinc.

The Montana display includes 125-year-old gold balances and weights, a historic photograph, and specimens of high-grade lode-gold ore

Colorado is well-represented in the Gold Rush Room by fine specimens of crystallized and leaf gold from Farncomb Hill near Breckenridge, a beautiful, 24-troy-ounce mass of crystallized gold from Leadville's Little Jonny Mine, and a superb collection of 20 large nuggets from the Fairplay placers. Among the specimens from the huge, gold-telluride deposit at Cripple Creek are an unusual, 6-inch, pseudomorph of gold after sylvanite and two pieces of "roasted" calaverite, high-grade calaverite that was heated to drive off tellurium, leaving behind spherical beads of bright-yellow gold.

"The 1850s and early 1860s saw numerous western gold rushes," McGeorge points out. "Although none were on the scale of California, or even Colorado, all nevertheless contributed to increasing national gold production. Gold rush prospectors often went on to find large deposits copper, silver, and other metals, the value of which eventually far exceeded that of all the gold they recovered."

After an 1853 strike attracted 1,000 California miners to Coos Bay, **Oregon,** richer discoveries on the Powder and John Day rivers in 1861 and again at Baker City in 1863 touched off still larger rushes. Oregon's exhibit in the Gold Rush Room includes a 2-inch specimen of crystallized leaf gold from Baker City.

In **Washington,** rushes took place at Colville in 1855, Salmon Creek in 1886, and Liberty and Eureka creeks (the latter the site of today's Republic gold mine) in 1900. Washington is represented in the exhibits by a 1-inch mass of crystallized gold from the White Swan Mine in Baker County.

Gold production in **Idaho** began in 1860, when 7,000 miners rushed to rich placers at Orofino, then stampeded to strikes on the Salmon River the following year and on to the Snake River tributaries in 1862. Yet another rush lured miners to the Coeur d'Alene River in northern Idaho in 1883, where they found modest amounts of gold and one of the world's greatest silver deposits. Idaho is represented by a 2-inch nugget from the Orofino placers.

Utah hosted a rush to Bingham Canyon south of Salt Lake City in 1862, where miners quickly recovered 60,000 troy ounces of gold. Although miners later stampeded to strikes in the La Sal and Henry mountains and to the Sevier River, that first rush had by far the greatest consequence, for it resulted in discovery of the enormous Bingham Canyon copper deposit and development of a mine that is still producing today. Although the Bingham Canyon Mine is synonymous with copper, it has also yielded large amounts of byproduct metals, including more than 18 million troy ounces of gold. The Utah exhibit is highlighted by two-inch-long, elongated blades of crystallized gold and a cluster of gold wires on limonite.

Montana's adventure with gold began with a rush to Grasshopper Creek in 1862, then to Alder Gulch, Bannack, and Virginia City. In 1864, miners descended upon Last Chance Gulch at Helena and Silver Bow Creek near present-day Butte. The Silver Bow Creek gold miners discovered the huge Butte copper deposit, which would yield millions of troy ounces of byproduct gold. The Montana exhibit includes a section of a high-grade gold vein from the Mineral Hill Mine at Jardine and a 6-inch piece of alluvial gold in matrix from an outcropped vein that once fed the Silver Bow Creek placers. Other Montana specimens include gold on a quartz-limonite matrix and a 2-inch piece of crystallized leaf gold.

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The Gold Rush Gallery *from page 22*

Strikes in the early 1860s along the Gila and Colorado rivers sent miners rushing into what is now **Arizona.** Later discoveries triggered rushes to La Paz, Ehrenberg, Rich Hill, Hassayampa, Prescott, and especially to Wickenburg, where the famed Vulture Mine would become Arizona's biggest gold producer. Arizona's specimens include a 3-inch gold on hematite from the Dutchman Mine at Bouse in La Paz County and a 2-inch gold in quartz from Sells in Pima County.

Historians believe that prospectors first found gold in **South Dakota** in 1834. But the Black Hills gold rush of 1875-76 didn't take place until a U.S. Army exploration party commanded by Brevet General George Custer made a strike on French Creek near the present-day town of Custer. After strikes in 1876 in the Deadwood Gulch area, miners founded the boomtowns of Deadwood and Lead (rhymes with "bead"). One of these discoveries was an outcropped vein, or lead, that would be developed into the Homestake, America's greatest gold mine. The Homestake produced for 125 years, turning out a phenomenal 40 million troy ounces of gold. South Dakota's specimens in the Gold Rush Room include three large pieces of high-grade gold in quartz from the Homestake.

Although prospectors found small amounts of gold in **Wyoming** along the Oregon Trail near the Sweetwater River in 1842 and again in 1855, it was an 1877 strike near South Pass that set off a rush of 8,000 miners who founded the boomtowns of Atlantic City and South Pass City. Wyoming specimens in the Gold Rush Room include six half-inch gold nuggets from the Atlantic City Mining District in Fremont County.

Alaska hosted America's last historic gold rushes in the early 1900s, when miners from the Klondike District in Canada's Yukon Territory made strikes near Fairbanks and Nome. Alaskan specimens at the National Mining Museum include a 4-inch nugget from Nome's beach placers, an eye-catching 3-inch nugget from the Kuskokwim River, and a large, cut and polished section of high grade gold in quartz from the Grant Mine in the Fairbanks District. The Grant Mine exploited the vein system that was the primary source of gold for the Fairbanks-area placers, which over time yielded 8 million troy ounces.

Although the Gold Rush Room has no formal historical exhibit for Canada's Klondike rush, it does display a fine, 25-troy-ounce nugget from the Klondike River. Also on exhibit is an outstanding collection of 27 nuggets, each 3 to 4 inches in length, from the Lena River District in Yakutsk, Siberia, Russia.

Gold is not the only mineralogical attraction at the National Mining Hall of Fame & Museum. The museum's Crystal Room features exhibits of Sweet Home Mine rhodochrosite provided by Bryan and Katherine Lees of The Collector's Edge, along with wonderful cabinet specimens from the world class collection of Keith and Marana Proctor. Also on exhibit are emerald gems and emeralds in matrix from Zimbabwe, the Missouri Collection of Southeast Missouri Lead District minerals, the Anaconda Collection, a worldwide array of mine specimens collected by Anaconda Copper Co. geologists and never before displayed publicly, and beautiful specimens from the Leadville (Colorado) Mining District provided by mineral dealer Dave Bunk, formerly a mining engineer with ASARCO's Black Cloud Mine at Leadville.

Sam McGeorge, curator of the Gold Rush Room, says "[Gold rushes] represent the very appealing elements of romance, adventure, individualism, and free enterprise."

McGeorge believes that the public considers minerals to be among the most appealing aspects of mining. "Mining has provided the lion's share of all the specimens we see in collections and at shows today," he says. "And here at the National Mining Museum, we've worked hard to assemble a mineral collection that does justice to the mining industry."

The National Mining Hall of Fame & Museum, located in Leadville, about a two-hour drive west of Denver, is open daily from May through October, and Monday through Saturday from November through April. For additional information, contact the National Mining Hall of Fame & Museum, PO Box 981, Leadville, CO 80461, (719) 486-1229, or visit the web site www.mininghalloffame.org.

Lucky Strikes

Many Major Mineral Finds Were Purely Accidental

Story and Photos by Bill Evans

The deposits that produced the world's finest silver minerals were first found by two teenage shepherds near Kongsberg, Norway!

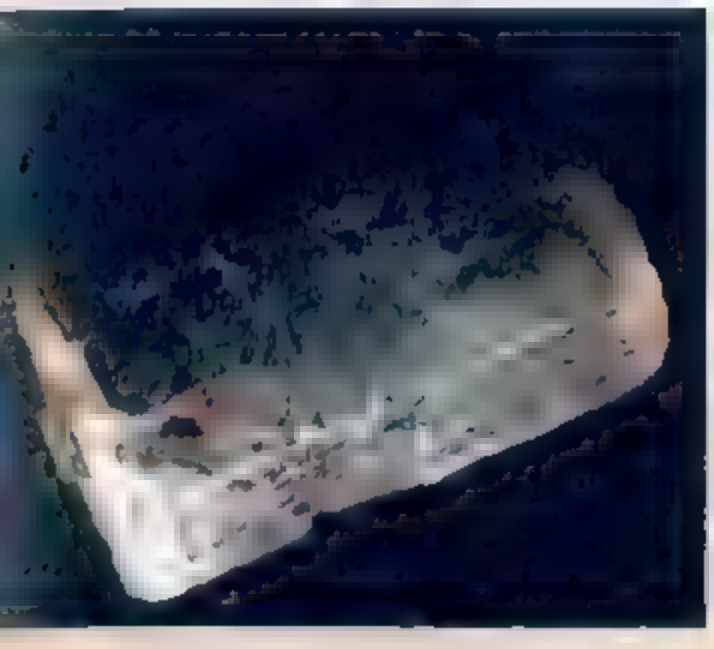
California s gold rush began with the discovery at Sutter's Mill.

Every collector has dreamed of stumbling onto some rich occurrence of gold, silver, or fantastic mineral crystals. Certainly, that was the goal of every old time prospector. So it is not surprising that many of our better known metal, gem and mineral deposits have literally been stumbled upon accidentally by people who were not even remotely aware of or looking for such riches. These well-documented finds resulted in a major impact on the gem, metal and mineral business.

The classic European unintentional find is probably the amazing silver deposits at Kongsberg, Norway, though Germany's initial discovery of silver before 1,000 A.D. would get a strong vote. Not that there weren't metal deposits known and worked in ancient times, but there can be little doubt that most of those early discoveries were accidental, too, since knowledge of where to look for gem and mineral deposits was lacking. Unfortunately, there are no records of those discoveries, only evidence of mining and technical advances to tell us what went on thousands of years ago.

In this country, there have been plenty of accidental finds, far too many to be ignored in the history of collecting. While we can document a number of important finds accurately, there is a host of legends which, if they are believed, would raise the number of finds to an immense total.

One legend says a prospector's jackass kept staring off across a canyon until his not so-brilliant partner finally realized the mule was looking at a shiny vein of silver. That's supposedly how the great si-



The Russian emerald deposits came to light when a woodcutter found a green crystal in the roots of a tree.

A rancher found a red garnet in a wash, which led to the discovery of a fine grossular garnet source in Choahuilla, Mexico.

Two boys stumbled onto green tourmaline crystals on the slopes of a mountain in Maine making America s first gem discovery.

ver deposits around Burke and Coeur D'Alene, Idaho, were discovered If legends are to be believed, jackasses the four-legged kind have a nose for rich deposits. The accidental discovery of the rich Vulture gold mine, near Wickenburg, Arizona, is credited to Henry Wickenburg's four-legged partner, when wandered off and ended up pawing the ground rich n float gold

The first discovery o. gold in this country was a pure and simple accident In fact, the finder and his family didn't even realize the yellow rock he had found was actually gold! It happened when a youngster was playing with his bow and arrow in Western North Carolina, a rather remote area back in the late 1820s. The boy shot one of his arrows into the woods. Searching for the lost missile, he found a large yellow rock in a small streambed He though the rock intriguing because of its color and its exceptional weight, so he brought it home His folks thought it made a really nice door stop until about 1828, when a visitor realized the 17-pound rock was really nearly pure gold

Once the word got out, America's first gold rush ensued Mines opened, and eventually, a government mint was established in Dahonega, Georgia, to turn the raw gold into coinage Today, you can visit the original Reed gold mine to see the results of this accidental find There's a fine small museum that tells the story of this find

Credit for the earliest gem find in America goes to two young fellows hiking the mountain slopes of western Maine They may have been out looking for something in the late fall of 1820, maybe even minerals, but no one knows for sure. What we do know is that Elijah Hamlin and Ezekiel Holmes stumbled upon small, gemmy, green crystals, which they picked up and brought home, having no idea what they were Before the crystals could be identified, a heavy snowfall covered the slopes of what was later named Mount Mica, near Paris, Maine By spring, the boys knew what they had, and the search for the source began This resulted in the development of the first of what proved to be dozens of gem pegmatite deposits in that portion of Maine. Even in the last few decades, wonderful gem discoveries have been made there.

The Hamlin family went into the mining business and did quite well In fact, Hannibal Hamlin became Governor of Maine, moved on to the House of Representatives in Washington, then on to the Senate When Abraham Lincoln ran for his first term as President, his running mate and Vice President was none other than Hannibal Hamlin, whose family fortune got its start with an accidental discovery of gem tourmalines on Mount Mica

Speaking of mining, did you know President Herbert Hoover was a well-known mining engineer before getting involved in politics? He and his wife also translated the first book ever written on mining and metallurgy, *De Re Metallica* from the original Latin

Long before Columbus sailed the ocean blue, great mineral discoveries had been made accidentally Perhaps the most important early find in southeastern Europe was silver in the mountainous regions where deposits now known as Schneeberg, Frieberg, Annaberg and Johanngeorgenstadt were eventually developed Certainly, these mines helped bring Europe out of the Dark Ages. It was here that Europe's first mining academy was established at Frieberg and the secrets of mining and smelting were finally revealed

Just as important, the skills needed for modern mining were developed here, and as new deposits of ore were found all over the world, miners from this region were brought in to work the new finds and train the locals. Later finds in Norway, England, and even the United States benefited from the skills developed in the German silver mines.

The initial find of silver in Germany is credited to a horse in the early 900s A D While his rider was answering a call of nature, the impatient horse kept pawing the ground When the soldier returned, he realized his mount had pawed away the heavy moss growing on a rock exposing a shiny vein of silver Actually, the metal may have been silver-bearing galena, but the horse had pawed his way into a rich silver lode. The importance of this find and the subsequent mining industry that developed here can not be overestimated for the Germans gradually developed virtually all the important mining techniques that were used in the following centuries.

The mining techniques that evolved in this region were closely guarded secret until the mid-1500s, kept among family members who worked in the mines and processed the ores. Such secrecy was not unusual in those days, and it really hindered mining development, since it was necessary that each new mining region either had to import someone with the knowledge or discover how to mine metal ores independently

German mining techniques might have remained a secret forever, but in 1553, a German doctor by the name of Georg Bauer, who lived in the German mining region and who wrote under the name Agricola, published a huge volume revealing the secrets and methods of German miners. Written in Latin, this book had a huge impact on metal mining, as it allowed anyone to get into the business successfully and fairly rapidly. This remarkable book persisted on the desks of many mining engineers right into the 20th century and was translated into English by the Hoovers.

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Lucky Strikes *from page 29*

The silver deposit in Kongsberg, Norway, was discovered in July 1623. This discovery enriched the king of Norway and exposed a deposit that proved to be exceedingly rich in some of the world's finest wire silver specimens, many of which have survived and can be seen today in museums and private collections.

The Norwegian silver discovery was clearly accidental. Two young shepherds, Jacob Grosvod and Helga Verp, were tending their flock on an obscure Norwegian hillside. As they wandered the hillside one of their male sheep scraped his horns against a rock outcrop. This action, called whetting, exposed a shiny metal in the rock. The children, not sure of what had been exposed, took some home, where their father recognized it as silver! The children led him to the source of this precious metal. You'd think that find would bring the family fame and fortune, but that's not the way things worked in those days. Not unusual for the times, the family decided to keep the discovery secret and gather the metal themselves. But when Helga's father tried to sell some of the silver in town he was arrested for handling "stolen" silver. To get off the hook, he had to tell the authorities where the silver had actually come from.

As soon as the word was out, the king claimed the entire mountain that held the silver deposit, naming it Kongsberg, or King's Mountain! The mining town that sprang up was known first as Kongingsberg, but later became Kongsberg. The king also decreed private mining was illegal. This declaration caused others who knew of similar silver outcrops in the vicinity to reveal their finds. The result was the development of a rich silver mining region. Experienced German miners were brought in to mine and train the locals in the fine art and science of ore mining and smelting.

The silver at Kongsberg occurred in rich hydrothermal deposits that extended deep into the earth. The main mine finally reached a depth of over 3,000 feet before closing. The silver was often found with fluorite and calcite and was usually enclosed in calcium carbonate and sometimes with crystals of the calcite. Some of the wire silver found here was in wires so thick as to resemble steel cables. Gorgeous curving tangles of silver wires were common. In the museum in Kongsberg today, there are specimens of silver whose wires are as thick as your thigh and curl up like huge ram's horns, which I think is most appropriate, since a ram uncovered the silver in the first place!

Several Mexico selenite deposits, including the amazing Caverna de Santa Barbara in Chihuahua, have been discovered accidentally.

For the collector a Kongsberg silver is one of the premier specimens to add to a collection. The finer specimens sell today in the high five-figure range, while smaller clusters of wires sell for several thousand dollars. Today, the mines are closed, which only adds to the value of specimens still extant. Fortunately, huge quantities of Kongsberg wire silver specimens survive, so you can enjoy seeing them in museums and private collections displayed at shows.

Another animal-related discovery of silver happened in the high Andes of Bolivia. A shepherd tending his flock on a steep hillside had a problem. One grazing creature had wandered higher and higher up the slope forcing the herder to literally climb hand over hand up the steep incline to retrieve the animal. As he pulled himself along using clumps of grass and small bushes, one of the bushes pulled loose, revealing lovely silver wires tangled in its roots. As a result, the huge silver deposits at Potosi, the richest silver deposit ever found in South America, were discovered. Unlike Kongsberg silver, few Potosi specimens have survived. They undoubtedly went to the smelter which explains their absence from displays of fine precious metals in museums and private collections.

Canada's greatest silver strike was stumbled upon by two railroad workers out cutting timber for railroad ties. A couple of small farming villages, Haileybury and New Liskeard, in a remote part of Ontario were growing enough produce to warrant a railroad to haul their product to market. The fact that New Liskeard was named for a Cornish mining village suggests that prospectors had been involved in the early days of the area. As James McKinley and Ernest Darragh paddled along the shore of Lake Temiskaming in 1903 looking for wood for railroad ties, they saw some rocks along the lake shore that seemed odd, odd because they proved to be rich silver ore. That find sparked a rush!

Out of this discovery came the town of Cobalt and huge masses of native silver. Some of these crystalline masses weighed a half-ton and more, and had to be broken up before they could be hoisted to grass. One later discovery was a wide streak of nearly pure silver that was exposed during the making of a road. It was dubbed the Silver Sidewalk! Pieces of it found their way into a few museums.

The silver around Cobalt occurred in huge masses of calcite. Most specimens from here ended up being cut and polished to show bright silver throughout the white calcite. Few free-standing, showy wire specimens were ever recovered, though when the calcite is etched away, some specimens of bright wires are revealed.

While Cobalt and the mines in that area never produced many specimens, it did serve important functions. It birthed the hardrock mining industry in Canada, and the wealth it produced helped trigger other ventures. Businesses got a financial start, railroads boomed, and Canada moved into the 20th century! The technology developed at Cobalt served miners well in other areas, and it woke up the world to Canada's potential as a source of mineral wealth.

Centuries after a horse played a role in revealing Germany's silver wealth, another horse helped the Spaniards in their quest for wealth in South America. As soon as Spanish explorers followed Columbus into the New World they began to see and gather gold jade.

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copper, and emeralds. It didn't take them long to find the sources of the gold and silver, though they missed the source of Mayan jade, a deposit only recently revealed by a storm in Central America. But as important as gold and silver were, the quest for emeralds grew intense when the Colombian natives, where the emeralds were known to occur, refused to reveal the exact location of their mines. Hidden in a dense jungle, these mines might have remained hidden much longer had it not been for a horse!

The Spaniards had pinned down the source as the land of the fierce Muzo Indians. Four times, the Spaniards did battle with these doughty warriors, and were always defeated! They won the fifth battle, but still no emerald mines were found. One day, a Spanish soldier was riding his horse along the banks of a murky river when his horse came a cropper. (I've walked the banks of that river; the ground is black and so is the water, as it carries the weathered remains of the black shale of the surrounding steeply carved mountains.) Stopping to clear the horse's hoof, the soldier discovered the trouble was a green gem emerald crystal. He had been riding his horse over an old mine dump! The secret was out, and emeralds began to pour out of Colombia, something that goes on even today, over 500 years later.

The other important find of emeralds, though it never equaled or even rivaled the Colombian deposits for quantity and quality, happened in Siberia, Russia, in 1830. I'm sure you realize that Siberia is not a pleasant place to live, in the dead of winter. And in 1830, the only source of fuel to keep out the intense winter cold was firewood cut from the vast forests of the area.

A woodcutter came across a dead tree that had been uprooted in a storm. Tangled in the tree roots were bright green crystals. The lucky woodsman immediately collected them and took them to the head of the Royal Lapidary factory in Ekaterinberg, now called Sverdlovsk. He immediately recognized the gems, and a rush ensued! There is no word about the fortunes of the woodsman. As things were in those days, I doubt he ended up with much.

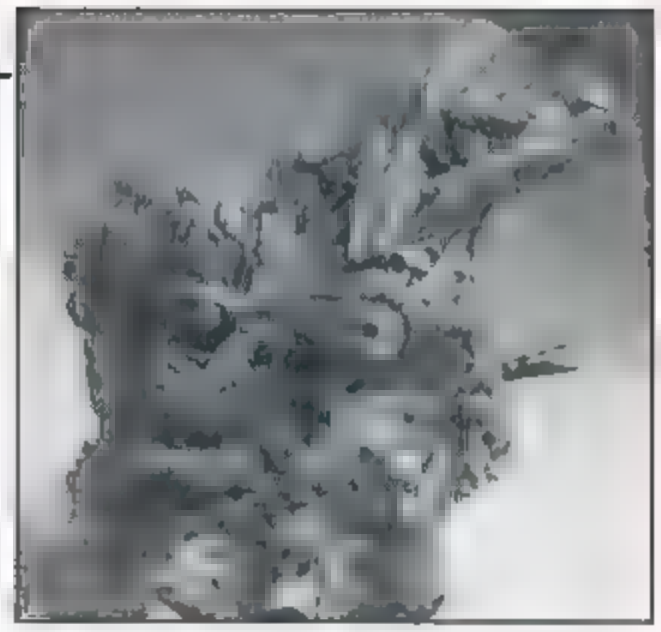
The deposits were quickly worked, producing large quantities of green prisms, of which only about 10 percent were actually gemmy enough to cut. The problem with the Russian emeralds is that they have formed in a dark-gray micaceous schist that more often than not was enclosed in the green crystals as they formed. Colombian emeralds, by contrast, occur in calcite veins, and while they have a multitude of inclusions, they do not suffer from ugly micaceous inclusions. Still, the Russian deposit produced superb gems that were used by Catherine the Great to decorate, among other things, her favorite horse's trappings. Today there is no emerald mining going on in Siberia. The deposits have been worked out as far as we know.

Another accidental gem find occurred around 1905, the exact date is not known. A cowboy was riding in a shallow valley in northern Nevada and noticed a rock that was flashing different colors. He picked it up and knew enough about minerals to know he had found a precious opal. When he told people about his find, a rush was started. Claims were staked and mining began. It is still ongoing today. Virgin Valley, as we now know it, immediately became news, as piece after piece of superb, gemmy opal was unearthed. This opal deposit is interesting because it yields wonderfully colorful, fiery opal, much of it replacing organic matter.

Virgin Valley opal is found at several sites in the valley. In one area in particular, superb opal is found in limb sections that had been buried by a series of volcanic ash and tuff deposits. As weathering proceeded over millions of years, silica leached out of the tuff and slowly replaced the wood cells, creating not just petrified wood, but opalized petrified wood. In many cases, the cell structure of the wood is preserved, as is the original shape of the limbs.

Opal has a definite affinity for organic things, witness the opalized plant matter, shells, and bones found in Australia. Perhaps the best example of precious opal replacing organic material is the virtually complete opalized skeleton of an ancient pleisiosaur found in Australia. The pleisiosaur was a contemporary of dinosaurs that existed over 100 million years ago.

There have been other surprising accidental finds of precious opal in Australia. It is well known that a group of prospectors working the outback made an accidental discovery of the White Cliffs area of Queensland. They may have been seeking opal, but they discovered it thanks to a kangaroo! Our prospectors had shot at a kangaroo for food, but the creature took off and they had to give chase. When they finally caught up with the kangaroo, it was right in the middle of a field of precious opal, lying about on the surface of the desert. This lucky and accidental find turned out to be one of Australia's premier opal deposits, which is still being worked today!



The famous German silver deposits were discovered when a horse scratched open a silver vein.

The most unusual accidental find of gold in Australia that I know of happened when two fellows were bumping along in their horse-drawn wagon. The dusty road was rutted, and normally, bumps were ignored. However, when they hit a particularly nasty bump, they stopped to check the wagon for damage. That's when they noticed something odd about the rock that caused the bump. It had color. They realized they had run over a gold nugget! They dug it up and hauled it to a scale. The "nugget" weighed over 3,000 ounces and was given the name Welcome Stranger.

There are several stories about accidental discoveries of diamonds. The first diamond found in recent decades in China was picked up by a farmer plowing his field. Then there was the young jogger who was cruising along a country road in Montana and picked up an odd, faintly yellow stone. It turned out to be a 75 carat diamond carried out of Canada by a glacier. A number of Canadian diamonds have been found like that, enough to encourage prospectors to brave the swampy tundra, insects, and cold to locate true diamond pipes. They have been successful in recent years, and Canada is now a contributing member of the diamond industry.

There have also been accidental discoveries of diamonds in Africa, but no record was kept of these earlier finds. The find most accurately documented was made near the confluence of the Vaal and Orange rivers in what was then known as the Cape Colony. The stone was actually spotted first by a young Hottentot of the Griqualand region named Klonkie. The glassy stone meant nothing to him, and he hit it with a stick to his friend, Erasmus Jacobs. In those days, kids played a game called Five Stones. The odd stone was added to Erasmus' play stone cache. He brought the stone home, but left it outside with his other stones.

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ROADSIDE PANNING SITES IN CALIFORNIA

Part IV: Mendocino, Merced, Modoc, Mono, and Monterey Counties

Story and Maps
by David and Cloris Walker

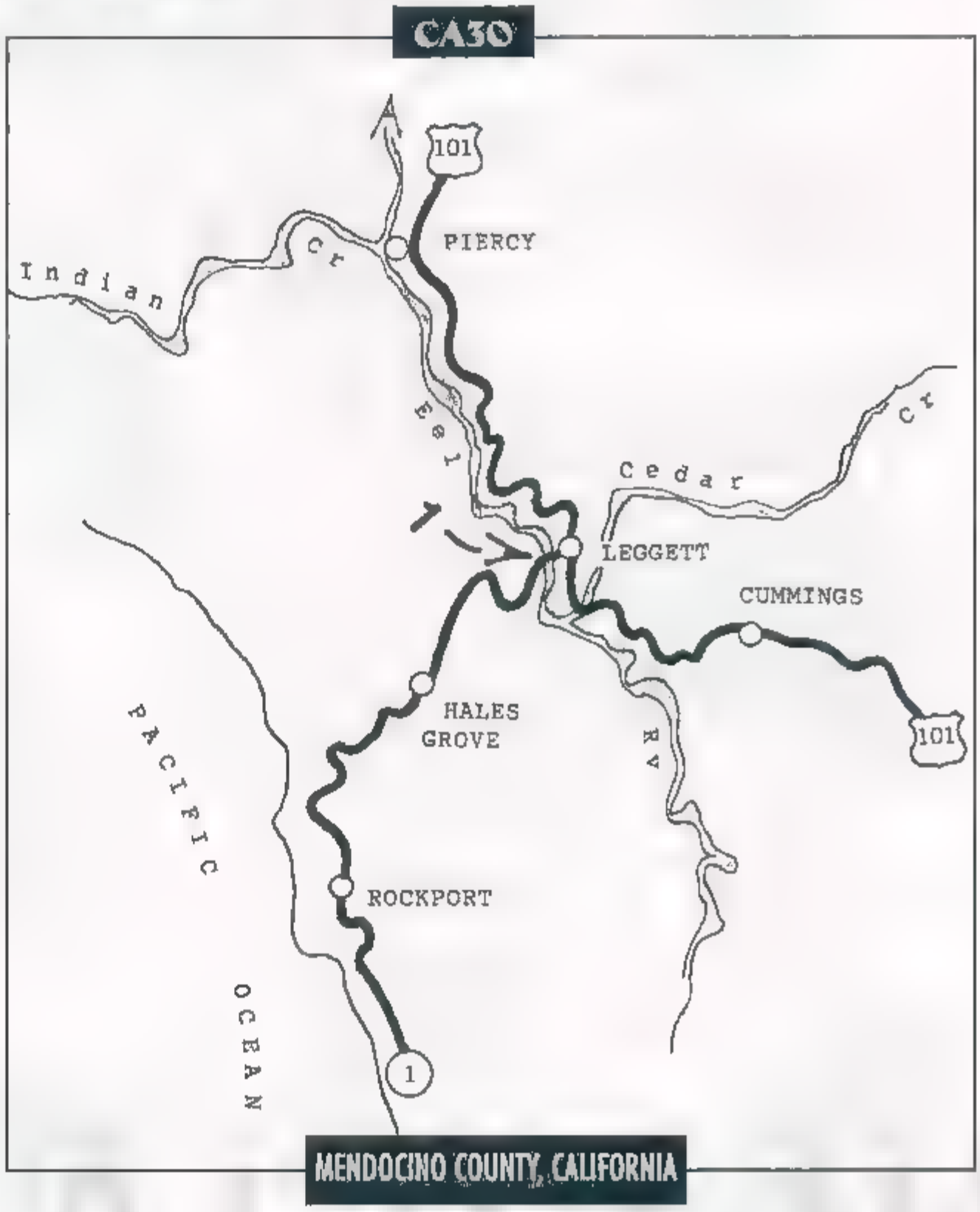
This is the fourth in a series of 10 articles containing county by county maps of suggested panning and screening sites at highway stream crossings where appreciable finds have been previously reported on upstream watersheds. The principles of erosion make it likely that minerals and gemstones have been deposited in river gravels awaiting removal by a rockhound with a pan.

Obviously, a highway convenience study of this kind is most advantageous for seniors and others who prefer panning under a nice, shaded bridge crossing to tramping over hill and dale. It also eliminates the necessity of locating and getting permission from property owners.

Don't forget, however, that the government to which these rights of way belong has some regulations of its own. Be sure to observe the usual safety and environmental standards if you want to collect without a hassle.

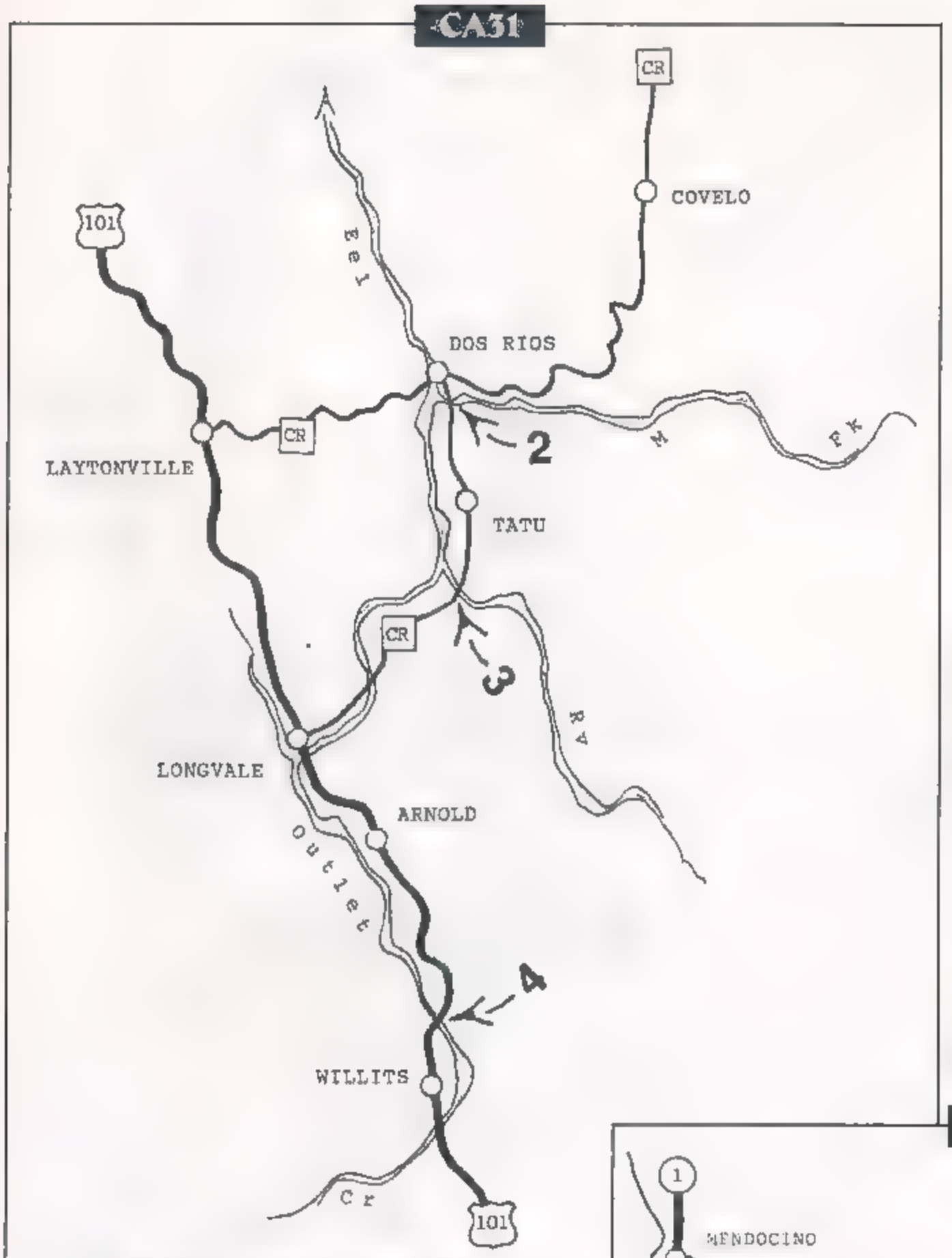
The maps provided contain the most up-to-date information available to us, but it is advisable to consult a current state highway map when planning an outing for overall orientation in the field and because highway designations have been known to change.

So good luck! While we can't guarantee you'll hit the jackpot, we can almost assure an enjoyable outing.

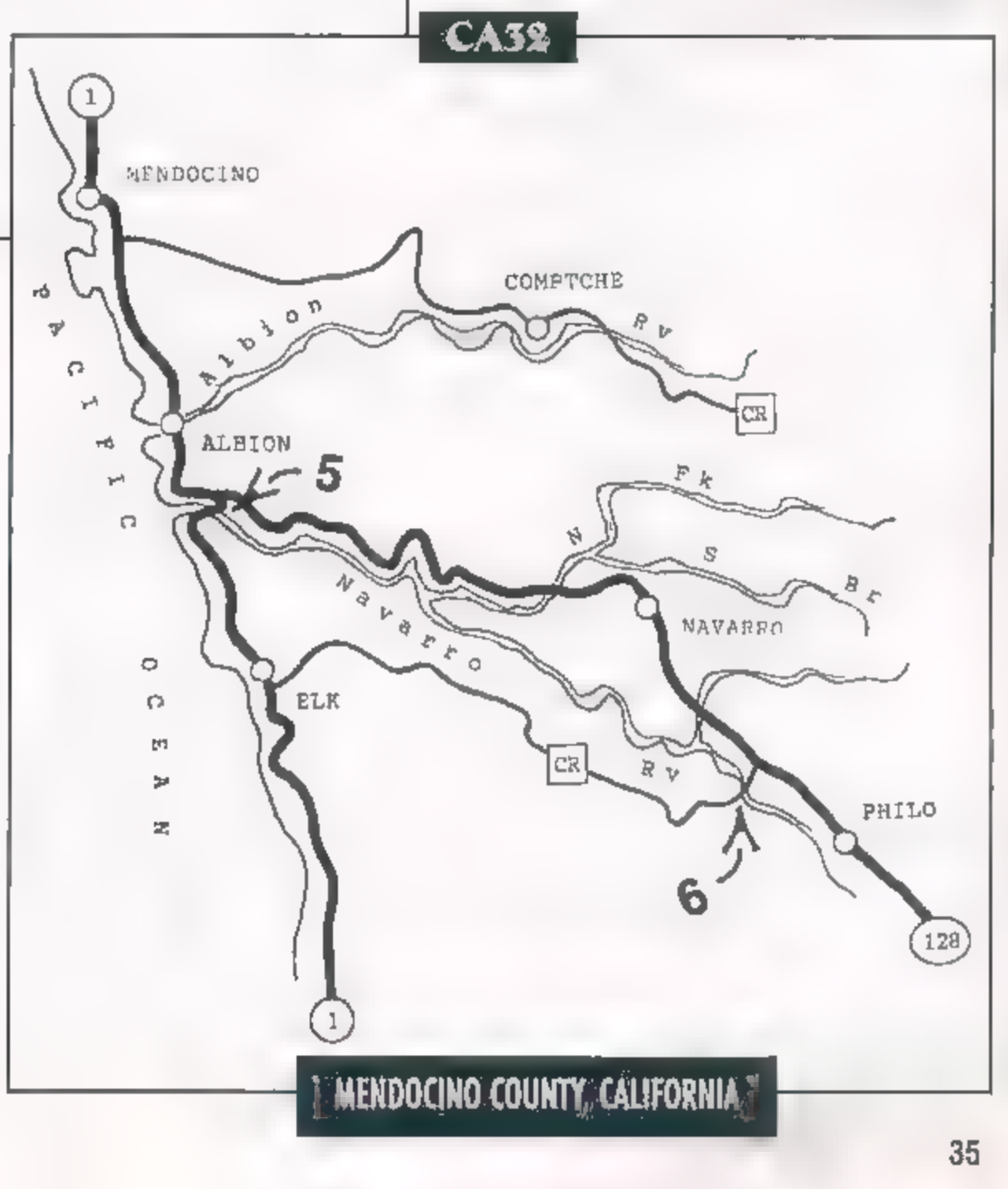


MENDOCINO COUNTY
(Maps CA30-32)

SITE 1 **Eel River/state Route 1** crossing near **Leggett.** Vicinity finds indicate jade potential.



SITE 2. **Middle Fork Eel River/County Road** crossing, near **Dos Rios.** Vicinity finds indicate jade potential.
SITE 3. **Eel River/County Road** crossing, near **Longvale.** Vicinity finds indicate jade potential.
SITE 4. **Outlet Creek/U.S. Highway 101** crossing, near **Willits.** Vicinity finds indicate garnet potential.



SITE 5. **Navarro River/state Route 1** crossing, near **Albion.** Vicinity finds include gold and platinum.
SITE 6. **Navarro River/County Road** crossing, near **Philo.** Vicinity finds include gold, platinum and zircon.

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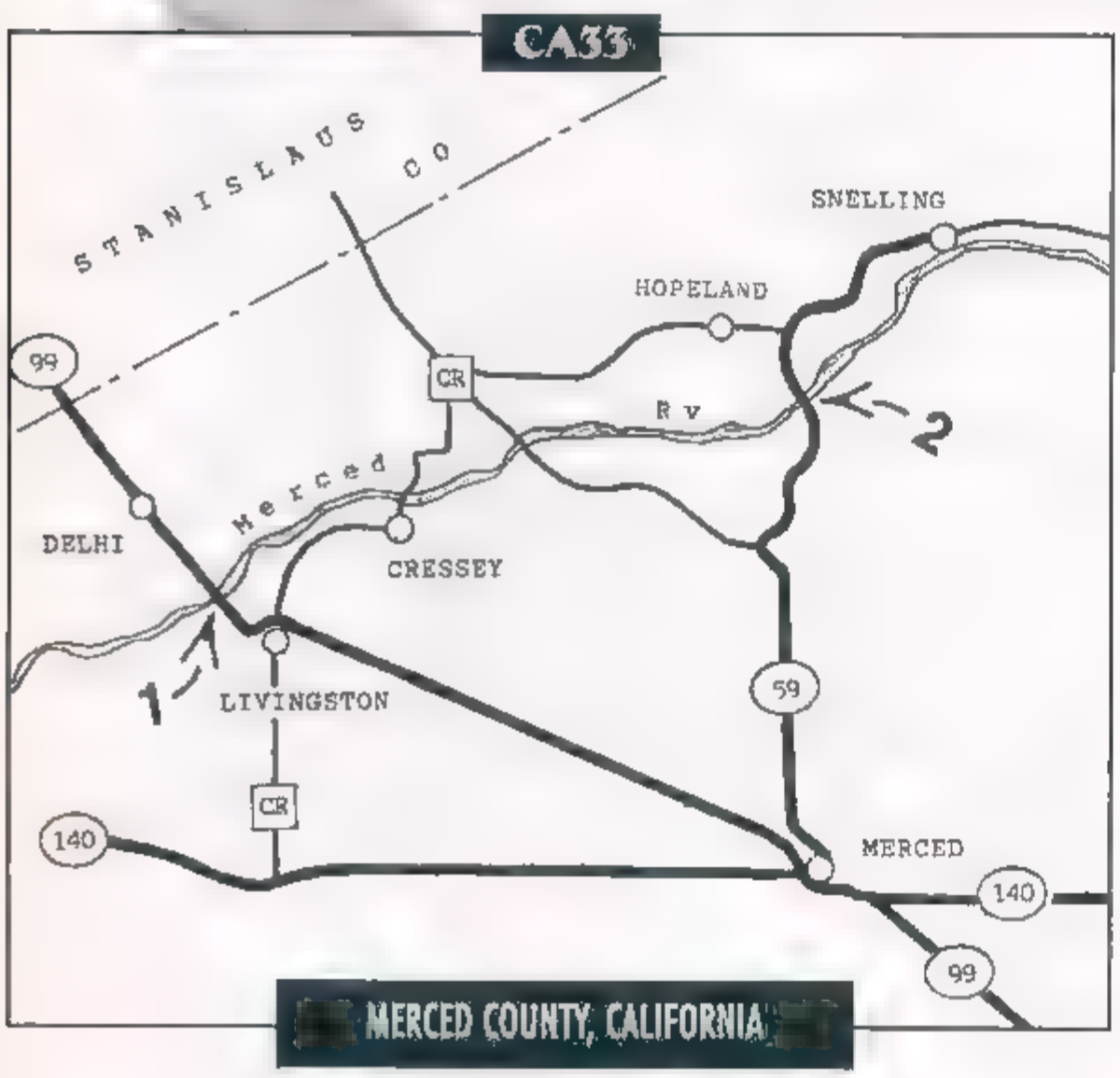
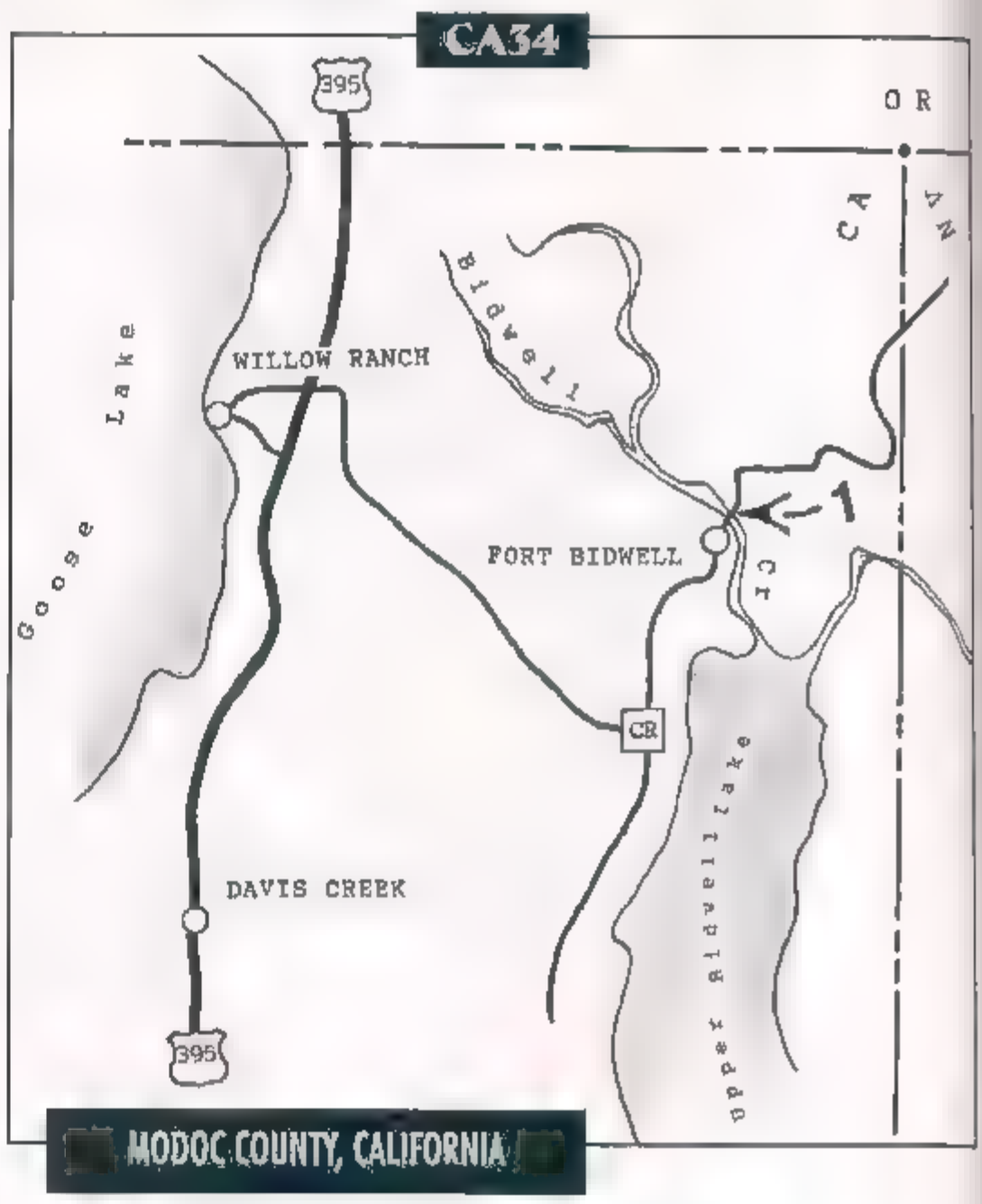
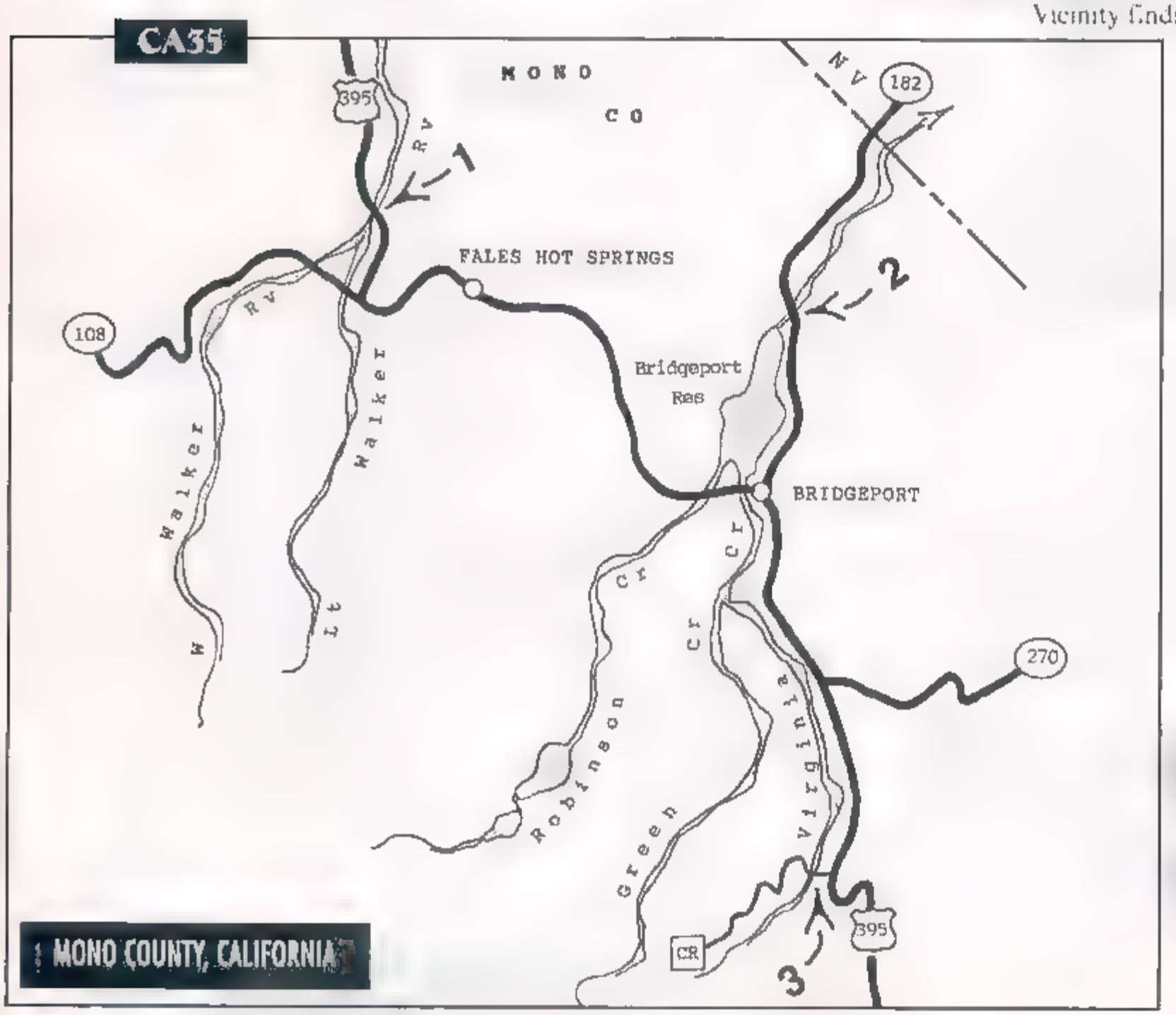


MERCED COUNTY (Map CA33)
SITE 1. **Merced River/state Route 99** crossing, near **Livingston.** Vicinity finds indicate gold potential.
SITE 2. **Merced River/state Route 59** crossing, near **Merced.** Vicinity finds indicate gold potential



MODOC COUNTY (Map CA34)
SITE 1. **Bidwell Creek/County Road** crossing, near **Willow Ranch.** Vicinity finds indicate gold potential



MONO COUNTY (Map CA35)
SITE 1. **Walker River/U.S. Highway 395** crossing, near **Fales Hot Springs.** Vicinity finds indicate gold potential
SITE 2. **Bridgeport Reservoir/ state Route 182** crossing, near **Bridgeport.** Vicinity finds indicate gold potential
SITE 3. **Virgina Creek/County Road** crossing, near **Bridgeport.** Vicinity finds indicate gold potential.

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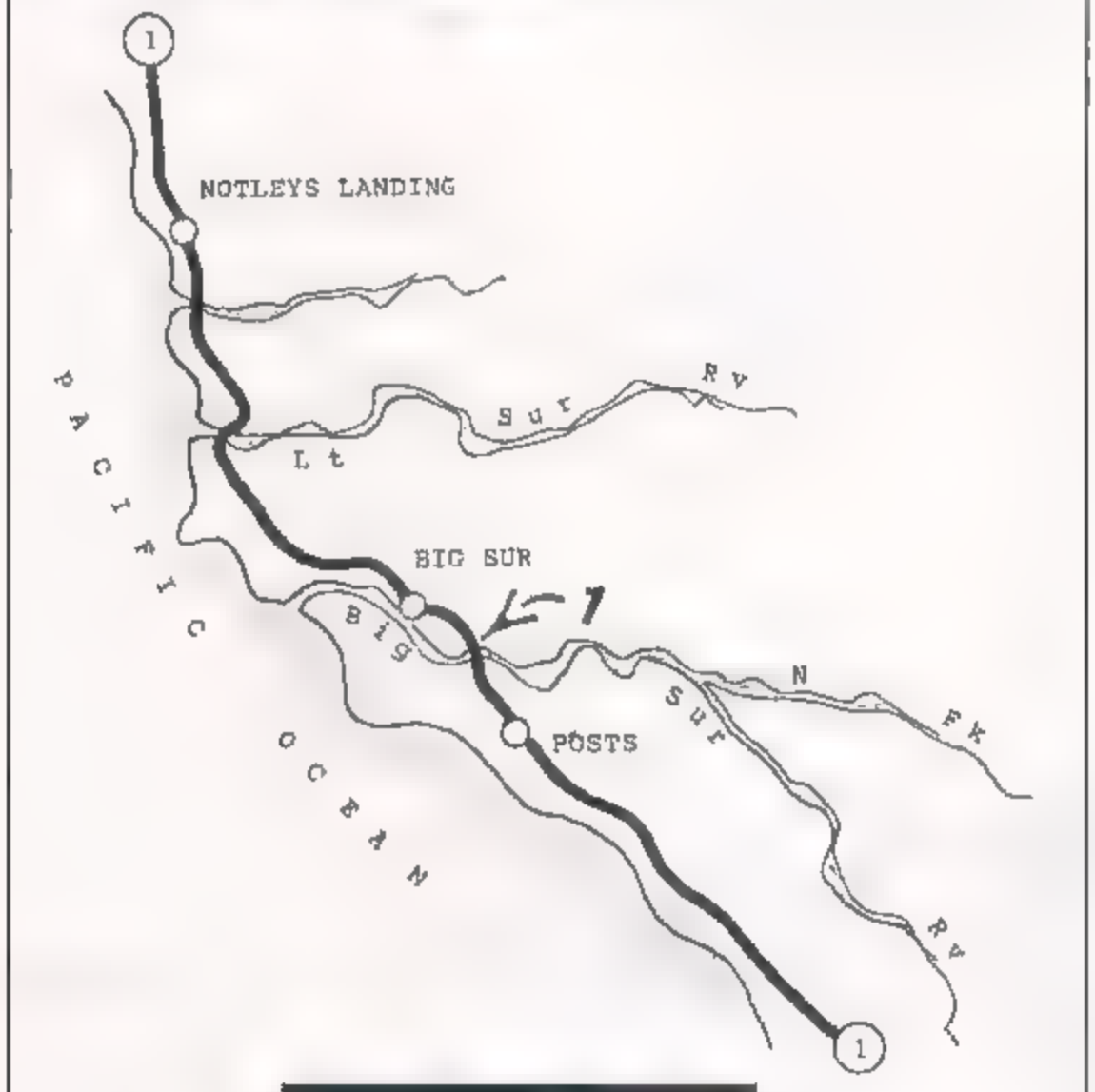
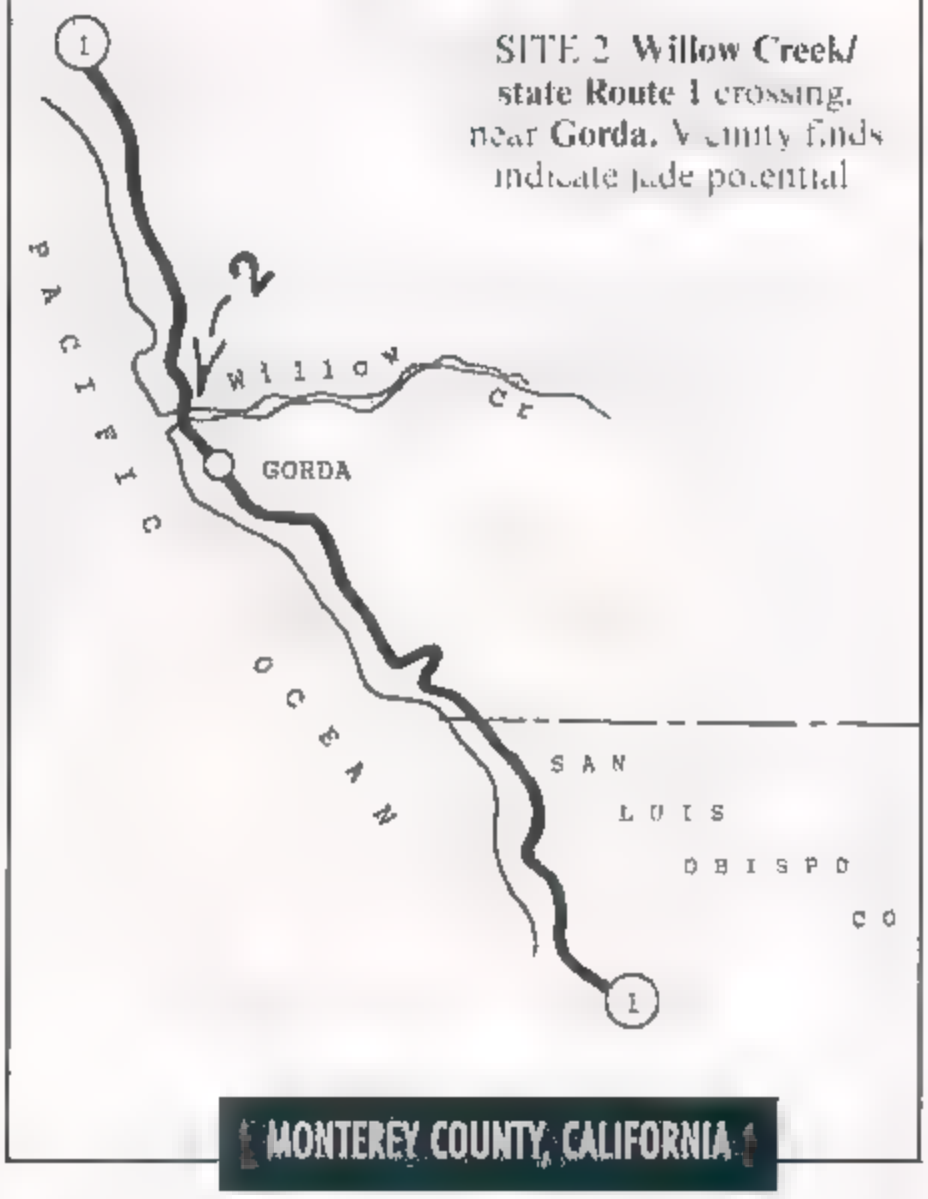
CA36



MONTEREY COUNTY, CALIFORNIA

MONTEREY COUNTY
(Maps CA36-38)
SITE 1, **Big Sur River/state Route 1** crossing, near **Big Sur.** Vicinity finds indicate jade potential

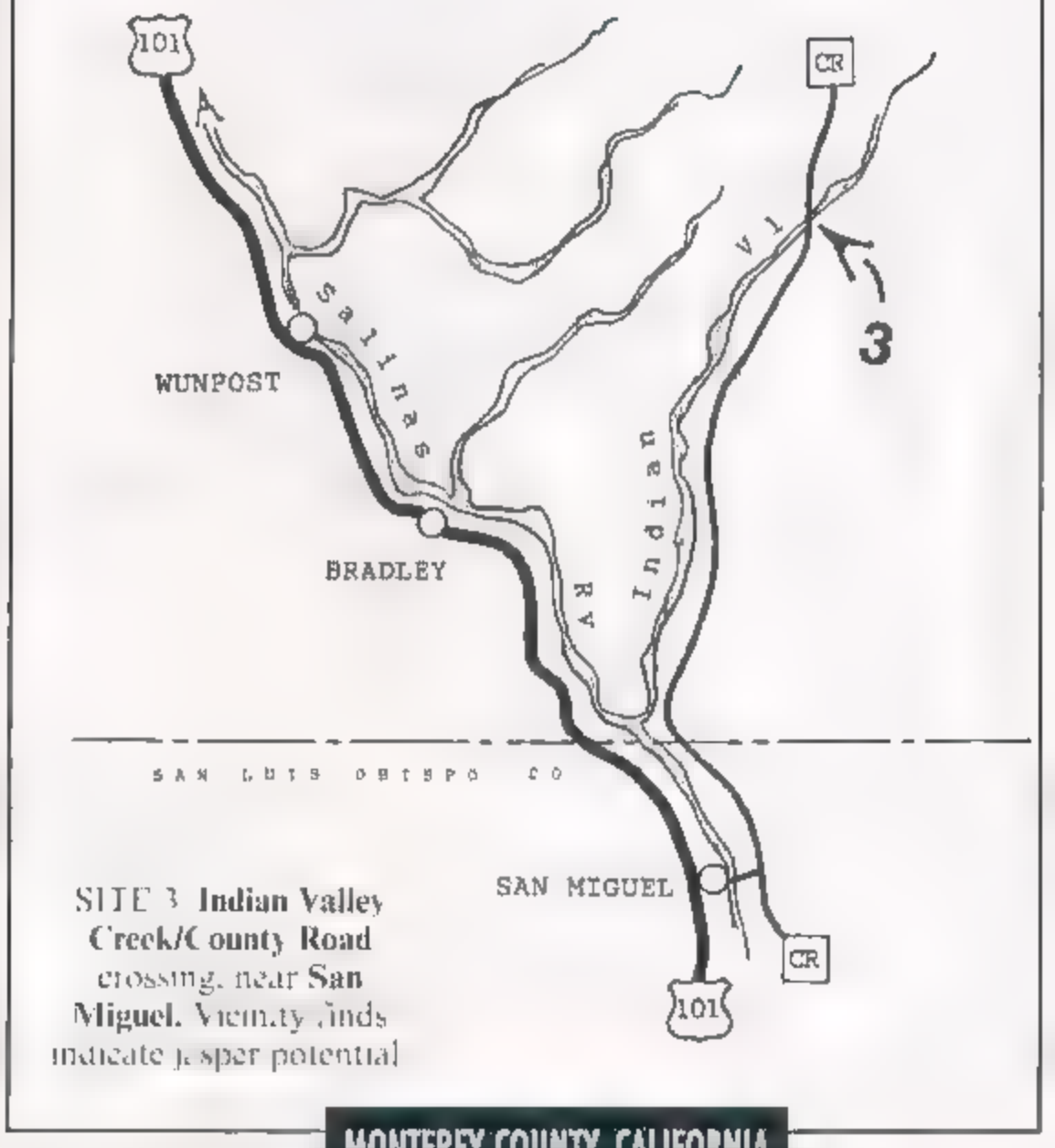
CA37



SITE 2 **Willow Creek/ state Route 1** crossing, near **Gorda.** Vicinity finds indicate jade potential

MONTEREY COUNTY, CALIFORNIA

CA38



SITE 3 **Indian Valley Creek/County Road** crossing, near **San Miguel.** Vicinity finds indicate jasper potential

MONTEREY COUNTY, CALIFORNIA

The official state highway map is suggested in conjunction with these maps for overall orientation in the field ®

THE FRUGAL COLLECTOR

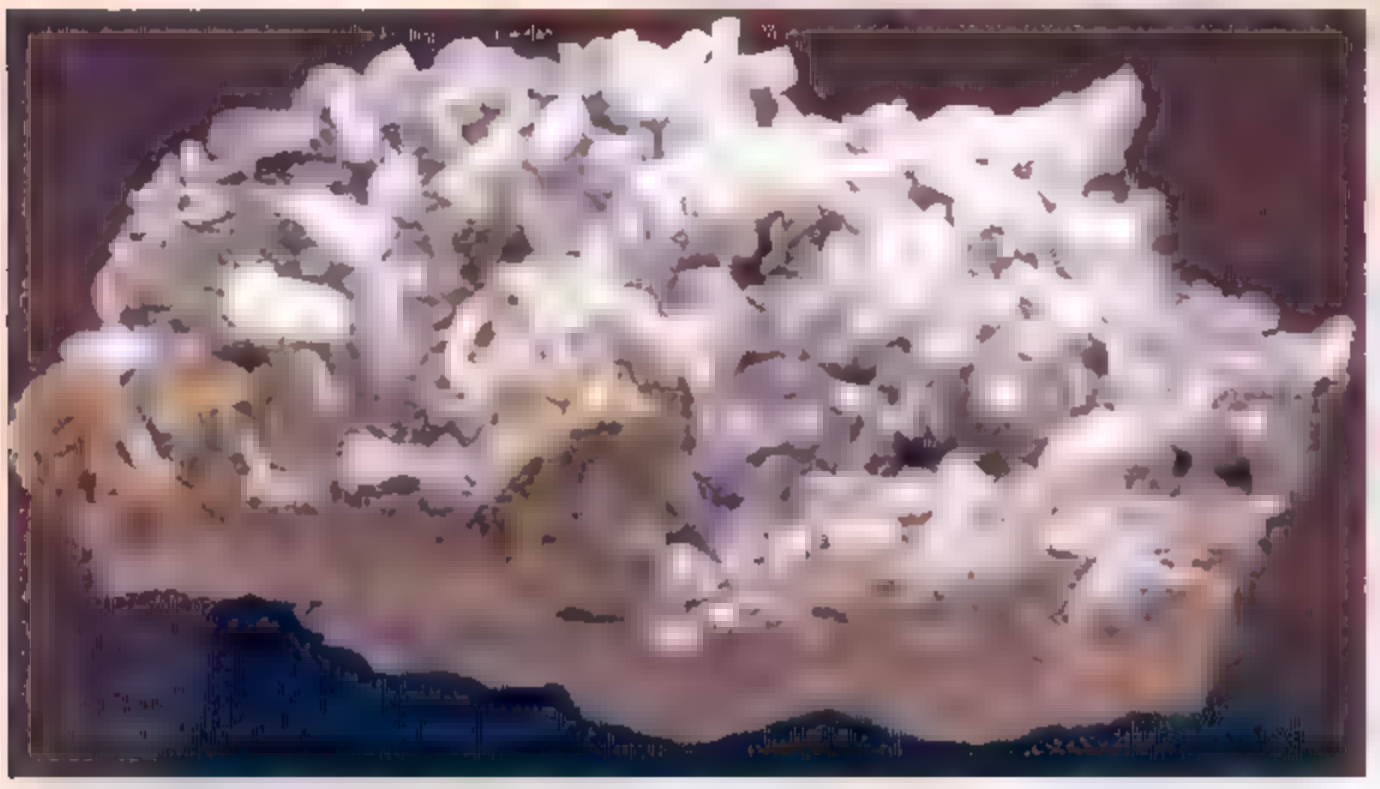
THE Feldspar Group

Part II:

Plagioclase Feldspars Form Gems and Nice Crystals

Story and Photos by Bob Jones

Editor's Note: Due to a printing error, the opening page of this story was omitted from the June 2005 issue of Rock & Gem. The story is reprinted here in its entirety. Rock & Gem regrets the inconvenience to its readers.



This fine example of crystallized albite comes from Beidenstock, Switzerland.

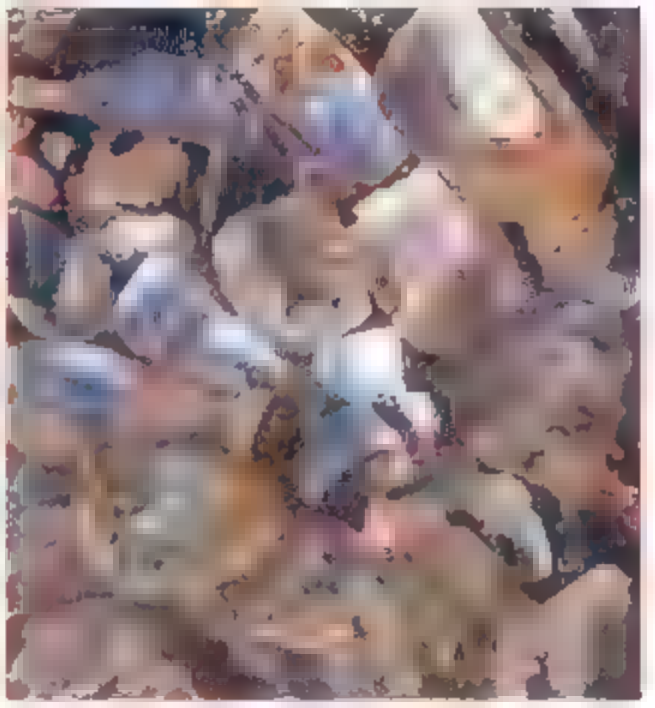
In Part I, I explained why the term feldspar refers to a group of minerals rather than a single species. Enough feldspars differ chemically that scientists have created two major groups and a couple of minor ones. One group, based on chemical content, contains members of the potassium feldspar group: orthoclase, microcline and sanidine. These were described in Part I.

Here, I'll discuss the second major group, the plagioclase feldspars, a much larger part of the feldspar species. The group includes albite, oligoclase, anorthite, andesine, labradorite, bytownite, and anorthoclase. Within some of these species are useful varieties. Oligoclase, for example, can occur as sunstone, moonstone and peristerite. These three varieties depend on light phenomena for their special features.

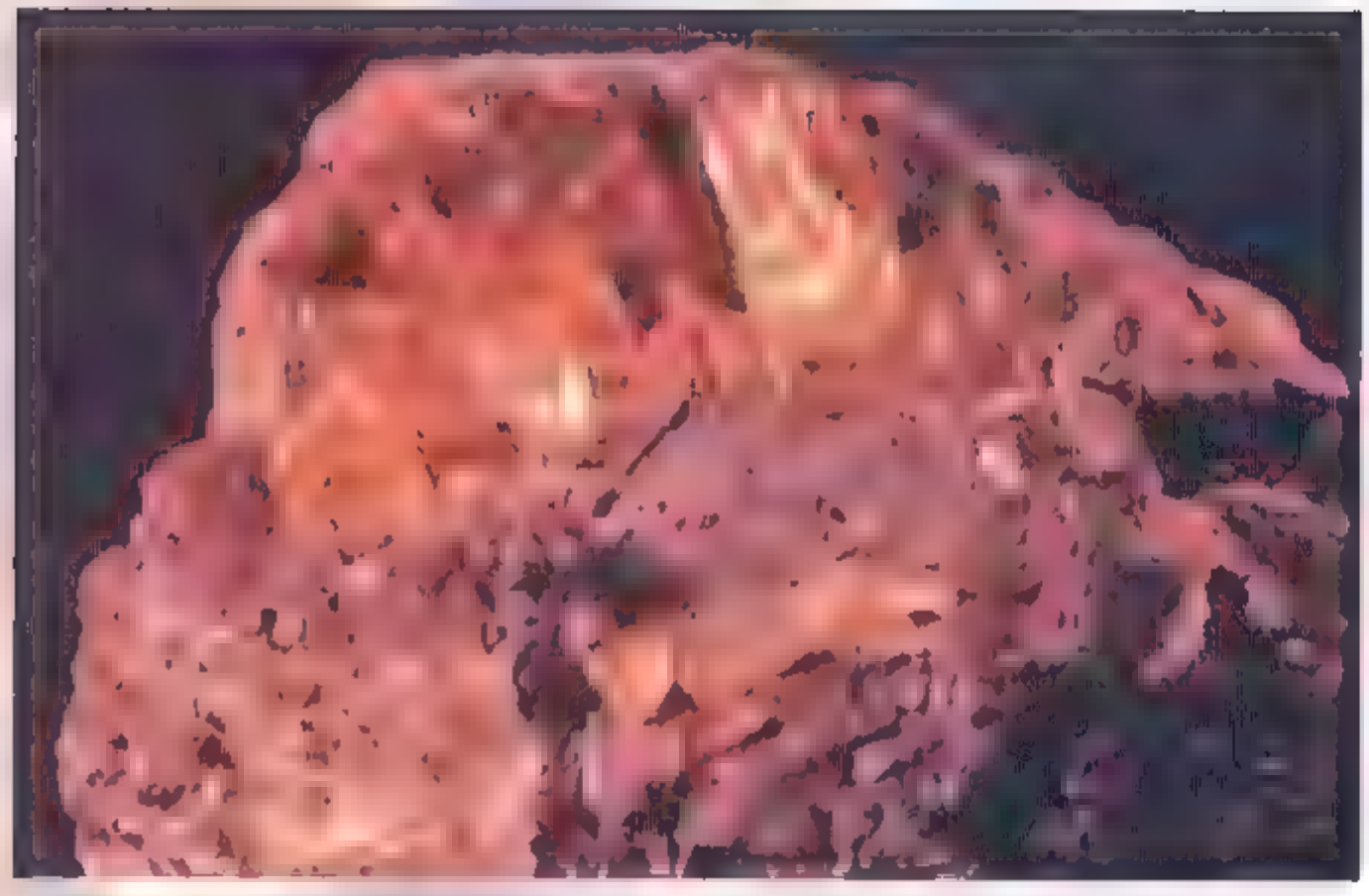
What distinguishes these mineral species from the potassium feldspars is their chemistry. While potassium is the main cation in the potassium feldspars, the plagioclase group is sometimes called the soda feldspars and the lime feldspars, since sodium or calcium, and sometimes both, is their main metallic ingredient. A third smaller group has barium as the main metallic element, but there are only a couple of unimportant barium feldspars.

To add to the confusion, combinations of sodium/calcium, potassium/barium or potassium/sodium may act in concert. This is possible because those metal ions have similar valences and their atoms are close to the same size.

Crystals of cleavelandite and quartz play host to bicolor elbaite, another pegmatite mineral.



A thin seam of albite in a lava flow near Camargo, Mexico, produces small gemmy crystals of moonstone.



Fine yellow gem labradorite, some of it still in matrix, can be collected from the site of a remote volcanic occurrence in Chihuahua, Mexico.

The most common member of the group is albite, which is frequently found in gem pegmatites. This sodium aluminum silicate is a major constituent of many pegmatites, in which crystals of sometimes amazing size are found. The crystals can have a flattened appearance, can be tabular, platy, bladed, massive, and even thin, laminar crystals tightly packed. One important role albite plays is to provide a platform upon which more important gem crystals are superimposed. The reverse is also true, as albite decorates previously formed gem crystals, like the tourmalines.

Albite forms fairly early in a pegmatite, so it is not unusual to see a wonderful beryl like aquamarine or one of

When the albite blades in a pegmatite deposit are thin and platy, and seemingly in nearly parallel clusters, they are called cleavelandite.

the colorful tourmaline group, particularly elbaite, perched on a curving mass of bladed white albite, or even decorated with small white plates of albite protruding from the gem crystal's prism faces. When the albite blades are thin and platy, seeming to be in nearly parallel clusters in a pegmatite deposit, they are called cleavelandite.

The great bulk of this feldspar mineral makes up the white groundmass of a pegmatite body. Graphic granite, always associated with pegmatite deposits, is largely massive albite with small quartz bars and angular crystalline quartz locked in it, making it look like some form of cuneiform writing.

Twinning in albite is very common, particularly in the variety pericline. Albite in discrete crystals will show Carlsbad, Bavene and Manebach twinning, just like the orthoclase feldspars. It is most often white, but can be slightly tinted, as seen in the pink to red granites of the Pike's Peak region. Rhyolite, a slow-cooling volcanic rock is very low in quartz and is composed mainly of albite feldspar. This is also true of other rocks such as andesite, syenite, and metamorphic gneisses and schists are largely altered granites. It's also found in limestone marble.

One of the most interesting habits of albite, and one that makes it quite highly prized, is its ability to develop in lamellar form. When its platy habit shows up internally, the results can be exceptionally attractive, as it affects the light entering the specimen. The thin albite plates stack in parallel, like sheets of paper and this causes light to be scattered, giving the specimen an opalescent appearance. When properly oriented and cut it shows a very attractive schiller effect, usually a moonstone blue.

Of all the members of this plagioclase group, albite is the most important and the most common. Many of the localities in which it is found are classic pegmatite deposits in Brazil. Some of the largest platy albite crystals mined came from the Itatiaia Mine in the form of cleavelandite. Of particular interest are the albite casts after spodumene from the Corrego do Urandin Dyke. Visit the wonderful Gem and Mineral Hall in the Smithsonian, you'll see a couple of amazing red elbaite crystal clusters, with each crystal tipped by blue terminations. These are the famous blue cap tourmalines from the Tourmaline Queen Mine. These specimens are so well known they have special names; the Candelabra, a group of three free-standing elbaites, is the most important. These lovely gem crystals are made even more attractive by the white skirt of albite upon which they rest.

Plenty of localities other than pegmatites produce nice albites. The old epidote locality at Untersulzbachtal, Austria, yielded small, white, discrete albites on byssolite. Some of the largest platy albite crystals ever found came from the Silver Crater Mine near Bancroft, Ontario. Measuring upwards of 10 inches, these are exceptional even for this common feldspar.

Orthoclase is normally a pegmatite mineral, but also occurs in other type deposits where it will often form simultaneously with albite. When these two form as alternating thin, platy crystals, they create a diffractionlike grid that produces a schiller effect. This variety of chatoyant feldspar is called peristerite, a gem variety of albite. It may be the albite-orthoclase mix or just albite. The resulting schiller effect may exhibit a bluish or even a golden color.

Peristerite has been called pigeon stone for reasons I know not. It can be cream colored or pale brown, even tending toward a brownish pink. What makes this a very attractive stone is its schiller. The finest peristerite is from Mountaingle, Ontario. It shows a lovely celestial blue flash. Other sources of peristerite are in Quebec and a more recent find in Kenya.

From my own experience, any time you are collecting in a pegmatite deposit, keep an eye out for peristerite, on several occasions, I've gathered orthoclase showing the typical subtle striations of lamellar crystals. These may show a weak to good schiller effect and deserve further attention. Since albite and orthoclase both tend to form lamellar platy structures in the right conditions, you can often find large pieces of feldspar with schiller due to interference with light by the lamellar crystals.

continued on next page

Feldspar Group *from page 41*

While most collectors do not seek to collect albite itself, many collections have fine albite crystals in them. These specimens are not collected because of the albite, but because of what it brings with it. Albite, in the form of cleavelandite, is the most common accessory mineral in pegmatite gem pockets, so it is the companion of many valuable and showy crystals of gem morganite, aquamarine, elbaite, liddicoatite, heliodor, and the like. It can host fine garnet gems, particularly spessartine. Many of the uncommon to rare pegmatite minerals are also found on and with bladed albite. This would include brazilianite, chrysoberyl, columbite, tantalite, and such other species collectors find attractive. While most collectors pay little attention to the albite, there is no doubt that the white platy mineral adds a measure of beauty to many specimens.

Lately an abundance of gem pegmatite minerals has come from Pakistan and Afghanistan. It's hard to believe that these deposits remained unknown to the outside world until the 1970s. At that time, the Russian government sent teams of surveyors and geologists into the mountains of these countries, ostensibly to seek gem deposits. (That they also mapped the area carefully and invaded Afghanistan later is simply coincidence.)

The geologists were thrilled to find, among the rock rubble on the mountain slopes, choice kunzites, elbaites, beryls, and other typical pegmatite minerals, which had been released from the host pegmatites by weathering. Of course this prompted efforts to collect, and mining of pegmatite pockets soon commenced. Marvelous aquamarines, fine tourmalines, peach colored morganites, some of the world's finest large kunzites, and other spodumenes have come to light in the last several decades. Perhaps the most exciting specimens I've seen are the foot-long violet kunzites on matrix, part of which is albite!

Gem mining in Pakistan and Afghanistan has become quite sophisticated. When the float crystals were first found, they were collected in burlap bags and dragged down the mountains. You can guess what they looked like when they reached the market. Today, when a pegmatite pocket is opened with crystals in situ, a diamond saw is used to remove the entire pocket intact. This virtually eliminates damage to the crystals and keeps them on the matrix, making them more desirable to collectors. The blocks are cut down to size and the sawn surfaces are worked on to make them look like broken rock. If you have attended the Tucson Show,

the Munich Show, the Denver Show, or other major shows with special exhibits, you have undoubtedly seen large, breathtaking pegmatite rocks of graphic granite with choice kunzite, aquamarine, or other beryls in perfect condition and of impressive size. Such specimens sell for tens of thousands of dollars.

The gem regions of these mountainous countries are now visited by a number of mineral dealers from all over the world. The local miners have, as a result, realized the value of their efforts. From visiting shows and selling minerals, the local sellers also have a good idea of what the market will bear when they offer minerals to visiting dealers. That, in turn, makes it tough for the Frugal Collector to get a nice example of Afghanistan or Pakistan pegmatite minerals.

I would suggest the Frugal Collector watch for the nice dark-green elbaites with pink terminations, usually 2 inches or so long, from Stak Nala, Pakistan. These are often heavily skirted with platy cleavelandite and make very showy specimens that are relatively inexpensive because they came out in such huge quantities.

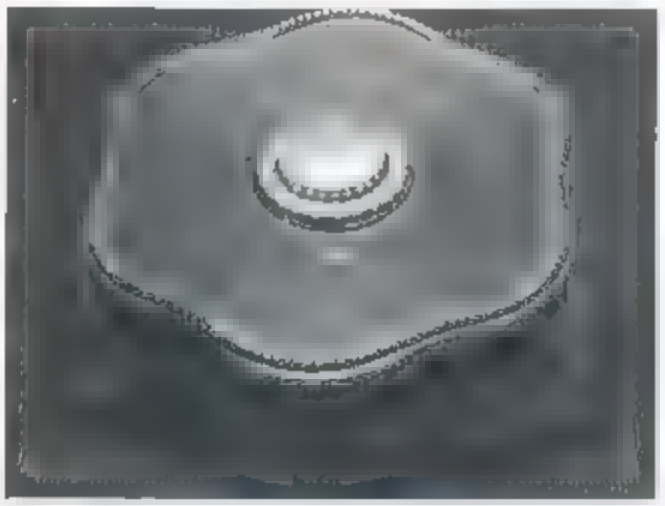
While albite is a sodium aluminum silicate, anorthite is a calcium aluminum silicate. In fact, these two feldspars form a complete series, with the sodium and calcium substituting for each other, and this, in turn, is what creates other species of the group.

Starting with pure sodium aluminum silicate (albite), calcium can gradually begin to replace the sodium, and the species oligoclase forms, with sodium still dominating. As the calcium and sodium approach a balance, the next member of the series, andesine, forms. Next comes labradorite, wherein the calcium content exceeds the sodium content. This is followed by bytownite, rich in calcium, with anorthite forming the pure calcium end of the series. You can see how identifying the members of this group can be a challenge, since there is no obvious physical way a collector can judge the level of calcium vs. sodium in a particular specimen. This is why it is so important to recognize the minor differences in physical features and, more importantly, the mode of occurrence of these feldspars.

Anorthite tends to form at higher temperatures than albite. It is frequently found as a rock-forming mineral in basic plutonic rocks and volcanics. It is rather difficult for the species to form discrete crystals when it is trapped in a molten flow, so it is seldom seen as collectible crystals.

One of the premier rock varieties containing anorthite, in my opinion, is called norite. There's nothing special about norite as rocks go, but in Southern California it takes on a special role for gem collectors. Norite is the gray, fine-grained rock that extends through much of the Mesa Grande and Pala-Fallbrook areas of Southern California. These place names should alert the reader that the norite does something special. The nondescript norite plays host to some of the most productive pegmatite veins and pockets in this country.

A prime example is the productive pegmatite called the Himalaya Mine of Mesa Grande. The white pegmatite vein contrasts sharply with the gray host rock. According to theory, as the pegmatite solutions forced their way into the norite, chunks of the gray host rock fell into the flowing solution, making crystal pockets more likely to form. During mining, these chunks of gray norite, called horses, signaled that pockets were nearby.



Moonstone, forming the button on this silver Fabergé bell push, has a variety of decorative uses.

The pockets in this pegmatite have yielded literally hundreds of fine gem elbaites, rare tantalite, superb quartzes, cassiterite, and even some zeolite crystals. The deposit extends for hundreds of feet, actually showing up on both sides of the mountain.

I was invited to dig at the Himalaya Mine several years ago when pegmatite gem bearing pockets were being encountered regularly. The owners had promised to call me when a gem pocket was hit. I received that welcome call during Christmas vacation, so my son Evan and I dashed over to Fallbrook to rendezvous with our host, Bill Larson. We were escorted underground into a tunnel that followed the pegmatite vein through the contrasting norite. Evidence of previously found pockets was obvious. Sure enough, we came to an exposed pocket of quartz and decomposing feldspar, mainly albite. Sticking out of the white to yellow feldspar clay were the ends of fat, colorful elbaite crystals. The crystals were no longer attached to the pocket walls where they had formed. Some scientists think pegmatite pockets often rupture, and this shatters the gem crystals from their pocket walls, even breaking some of them into sections. At times, you will find one portion of a crystal on the opposite side of a gem pocket from the rest of the crystal.

Evan did most of the digging that day. He was joined by Ralph Potter, now deceased, but at the time one of the owners of the property. Ralph's reputation as a pegmatite miner in that area is unrivaled even today. The end result of the digging was a couple of 5-gallon buckets filled with elbaite crystals and crystal sections. Some were attached to quartz. Other elbaites had platy albite attached. It was quite a day!

The classic source for discrete anorthite crystals, usually well under an inch, is in the volcanics of Mount Vesuvius, hardly an exciting collector source for minerals.

Andesine suffers the same fate as other feldspars, for it is usually massive, forming the main ingredient in andesite, one of the more explosive volcanic rocks. Some crystals do occur in small tabular form. These develop as triclinic crystals. The first triclinic tabular andesines were found in the Andes Mountains, after which the mineral is named.

Certainly, one of the more exciting members of the plagioclase group is the gray-blue feldspar rock labradorite, named for the Canadian province Labrador in which it was first found. Though it occurs largely as a rock-forming mineral, it can also be found as a wonderfully attractive transparent gem, suitable for faceting.

All massive labradorite is opaque, ranging from light to dark gray in color. There are two reasons for this. The gray color is thought to be due to microscopic platy inclusions of magnetite. While the labradorite crystals themselves create most of the color due to their interference with light, the platy magnetite adds to that rainbow of colors. When the iron oxide inclusions are hematite, a slightly different effect is seen. Resembling aventurine quartz, labradorite with hematite inclusions can be referred to as aventurine labradorite.

Labradorite makes a wonderful decorative stone, since it shows a bright multicolored schiller effect commonly called labradorescence. This is due to the lamellar development of the internal crystals, which can scatter light to create a rainbow of colors.

continued on next page

The rock occurs in a number of localities that are still open to collectors. My introduction to collecting superb labradorite happened on a trip up through upstate New York to Canada. My eye was attracted to a splash of rainbow color coming from rocks and boulders along the side of the newly built Interstate 87, not far from the famous garnet locality Mount Gore. I stopped to check out the source of this colorful display. It turned out that all the boulders on the sloping shoulders of the new highway were labradorite. They were later buried so grass and plants could be installed. Though I've never been back there, I have to believe there is still an abundance of fine gray-blue labradorite rock in the vicinity of that highway.

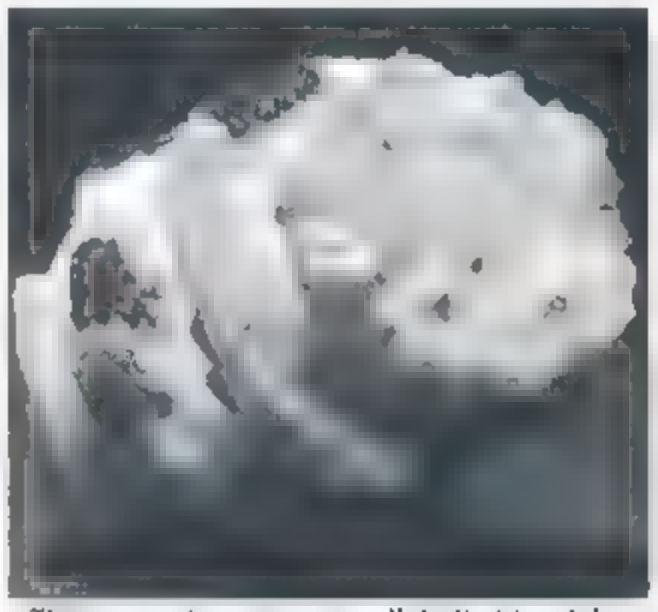
Fine cutting-grade labradorite is also found in the Russian Urals, while Greenland, Norway and Finland also yield superb examples. While traveling in Russia to work on the video "Russian Gem Treasures," I saw a number of fine masses of labradorite on display in the country's major institutions. But the surprise of the trip was the labradorite I saw on the grounds of the Kremlin.

We enjoyed the treasures inside the Kremlin, but the real surprise was the huge curbing blocks used as borders for the immense flowerbeds on the Kremlin grounds. They were different types of decorative stone, including marble and very fine dark gray-and-white jasper. The most impressive retaining wall was made of huge blocks of labradorite, each weighing hundreds of pounds. The square-cut, polished blocks measured about 3 feet long, 2 feet high and about 1 foot thick. I approximately 200 running feet. If I had had a hammer, I might have ended up in the gulag!

On later visits to some of the palaces and state buildings in St. Petersburg, we saw more decorative objects made from labradorite. I can only imagine what the Uralian mountain deposit must look like!

What gives massive labradorite its schiller, or labradorescent colors, is called an interference effect at thin films. As platy crystals of labradorite form randomly the rock hardens. These labradorite crystals lie at various angles within the rock mass. As light enters the surface of the rock it strikes those randomly arranged crystals at various angles, and each scatters the light so that a bright, fiery color, or several colors, may be reflected back to the viewer's eye. As you rotate the polished surface of the labradorite, the various angles of reflection create a panoply of color, which varies because of the thickness and angular position of the plates themselves. Since most of the crystals are close to the same size, you see mainly one color, blue. But you might see green, red, bronze, yellow, and violet to varying degrees. The result is a vibrantly colorful decorative rock, which can even be cut en cabochon and used in jewelry.

Another form of labradorite that is better suited to jewelry is the golden yellow material from a remote volcanic occurrence in Chihuahua, Mexico. I was fortunate to be escorted to this deposit by the man who discovered it, Benny Fenn, one of this country's important dealers in Mexican minerals.



This unusual specimen is albite that has taken the hexagonal shape.

The deposit is a volcanic flow, probably basalt, that is fairly thin as lava flows go. It measures a few feet thick, which may explain why the phenocrysts of labradorite might have formed as the lava cooled. The yellow labradorite crystal fragments measured from a fraction of an inch to as much as 2 inches across, they were completely gemmy and clear, with a nice straw yellow color. Crystals were so abundant that hammering and digging were not necessary, we simply picked up the loose crystals released by prolonged weathering of the deposit. A couple of hours of selective picking filled a bag with gem rough. These gems were originally thought to be bytownite and were sold as such, but testing showed them to be labradorite.

Labradorite phenocrysts in basalt and other lavas are not rare. The noted collector site at Rabbit Hill, Oregon, yielded what are called sunstones, yellow to red gems of labradorite. Sunstone is the state gemstone of Oregon because of several occurrences of the very colorful, collectible feldspar gem.

Oregon is particularly rich in sunstones, though it is not the only source. What make the Oregon sunstones unique are their exceptional color varieties and the cause of their varied colors. The colors range from yellow to red to green, and can even show a rare alexandrite effect. Microscopic bits of native copper scattered throughout the feldspar give the gems their unusual color. The largest stones found in the area can yield gems weighing several dozen carats.

The average rockhound can collect sunstone in Oregon on a state-owned section around Rabbit Hill. The place has been heavily collected, but digging only with hand tools is allowed. Nothing of a mechanical nature is allowed, and explosives are verboten!

One small group of feldspars deserves some mention simply because it is based on yet another metallic element cation, barium. Celsian and its paramorph paracelsian seldom develop as nice crystals. These barium aluminum silicates are only rarely found as small, sharp monoclinic crystals. They occur along the contact zones of manganese and sometimes barium deposits, but you'd be hard pressed to find one for sale.

The mineral hyalophane, a potassium, barium, aluminum silicate does form the occasional, water-clear prismatic crystal. They are quite small and come from the classic mineral source at Binnental, Switzerland. This deposit is an interesting metamorphosed marble limestone which has yielded a considerable variety of rare and unusual minerals. The Swiss hyalophane crystals are usually colorless, but can be lightly tinted yellow.

The only source of interest to most collectors is the now closed Franklin-Sterling Hill, New Jersey, region. Hyalophane occurs there as large, crudely formed phenocrysts in matrix. They are only of interest in identifying any specimen collected. Much more common at Franklin and Sterling Hill are solid masses and even some crystals of microcline, a potassium feldspar.

While the two parts of this article series do not cover all members of the group, those that are important as collector minerals or important as accessory minerals have been introduced. The Frugal Collector would do well to collect and study these group members, for they provide good examples of the monoclinic and triclinic crystal systems in which they form. Most feldspars are relatively inexpensive and, in some cases, readily collectible. R&G

ROCK & GEM

How to Find Bargains at Rock Shows

KIDS

The Three Apatites

Apatite is the general name for three phosphate minerals that contain calcium and phosphorus (like your teeth do) and one other element. The three apatites—fluorapatite, chlorapatite and hydroxyapatite—have many similar characteristics, but the difference is fluorine, chlorine or hydroxyl atoms in their crystal structure.

Fluorapatite from Otter Lake, Canada

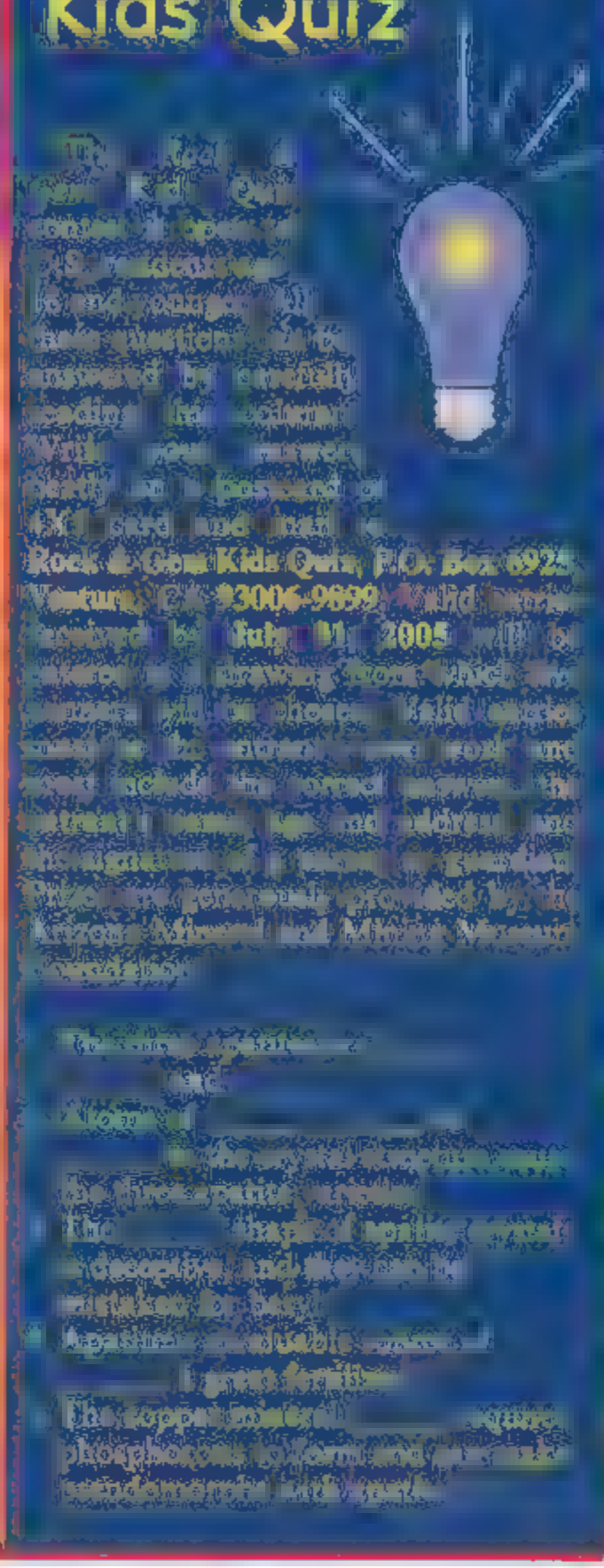
Apatite is a valuable source of phosphorus, which makes a great fertilizer. When apatite is available in the soil near a copper deposit, turquoise, which requires phosphorus, may be formed. Unusual specimens of turquoise in the shape of apatite crystals have been found at a locality in Sonora, Mexico. Recently, much larger specimens of this rare pseudomorph have been discovered in China.

Frederick Mohs chose apatite as number 5 on his scale of hardness. The name apatite comes from the Greek word for "deceiver," since its hexagonal crystals could be mistaken for more valuable minerals such as beryl.

Lovely, clear yellow to yellow-green apatite crystals are found in Durango, Mexico, generally offered as single crystals, sometimes on matrix. Larger, opaque green apatite crystals are found in Canada and often appear to be somewhat dissolved, with rounded edges and a waxy looking surface.

Apatite from Durango, Mexico

Rock & Gem Kids Quiz



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APATITE
CALCIUM
CHLORINE
FLUORINE
HEXAGONAL
HYDROXYL
PHOSPHATE
PSEUDOMORPH
WAXY

FIELD TRIP

BALMORHEA BLUE

Blue Agate in West Texas

Story and Photos by Robert Beard

The agate often occurs in fractures in the brown volcanic rock and ranges from dark gray to bluish gray.

During the summer, many rockhounds will find themselves driving across the country to their vacation destinations. The major interstate highways often pass through good collecting areas, but many collecting stops require significant time and may not be suitable for two-wheel-drive autos or large recreational vehicles. West Texas is a good example of this.

If you are crossing the southern United States from east to west, you may find yourself on Interstate 20, if you are traveling past Dallas, or Interstate 10, if you are going through Houston. A site that should not be missed if you are traveling in this part of Texas is the blue agate locality near Balmorhea. Balmorhea is just south of I-10, and just east of the intersection of I-10 with I-20. This is a great place to stop and collect some unique blue agate.

Balmorhea blue agate forms as nodules, crusts, and open-space fillings in a brown volcanic rock. The pieces I have seen can be described as a banded blue-and-white agate and as a light-blue chalcedony. I first learned of the Balmorhea blue agate from the original *Gem Trails of Texas* by James R. Mitchell (1958, Gem Guides Book Co.)

The latest reprinting of this book was in 1991. I have used this book for numerous rock and mineral locations throughout Texas, and it has always been useful. The book lists several other agate sites in the region, but since the agate at this locality was blue, it seemed worthwhile to check out.

When reading collecting guides, it is very important to follow every word. *Gem Trails* mentioned that the area had been well-known for years, and that collecting the agate was not as easy as it used to be. However, lots could still be found by rockhounds who were willing to take the time to do a thorough job of exploration. The real prize was said to be a vivid dark blue agate with bright, contrasting white bands, known as 'Balmorhea Blue.' *Gem Trails* also had a picture of a flat hill with small cliffs, and said that good collecting was at the cliff base. The washes were also described as very productive.

The Rockhound's Guide to Texas by Melinda Crow (1994, Falcon Press Publishing Co.) also lists the Balmorhea site. This is an excellent book for identifying collecting sites, and I have always found the information accurate. The book said that while the area used to be covered with chunks of blue agate, it was now quite picked over, and that most of the agate was pebble-size pieces. When two guides say that a collecting area is picked over, it's a bad sign.

The best, or rather worst, example I have seen of a wiped out collecting site is the famous carnelian agate locality located in the Florida Ridge area approximately 10 miles northeast of Deming, New Mexico. This site is referenced in *Gem Trails of New Mexico* also by James R. Mitchell, and *New Mexico Rockhounding* by Steve Voynick (1997, Mountain Press Publishing Co.). I first visited the carnelian agate site in the early 1990s and was able to find some beautiful carnelian pieces. My family and I returned several times over the years, and the pieces we found, when we found anything, kept getting smaller and smaller. By the time I returned for a final visit in the fall of 2001, I did not find a single piece of carnelian.

Of course, as a prospector and exploration geologist I am an eternal optimist and refuse to believe that a site is picked over. I have found lots of good specimens at many sites that were described as picked over in mineral guides and geologic papers. If anything, "picked over" just means you may have to work harder to find what's there.

The chance to find some collectible blue agate was too good to pass up. My family and I had the opportunity to visit Balmorhea in July 1999 while making a cross-country trip from Pennsylvania to southern New Mexico. We were traveling west on I-20 from Abilene, and Balmorhea was south of the highway. We had to make a slight detour south on state Route 17, but we soon were in Balmorhea.

The guidebooks indicated that we had to stop and pay a $2 fee at the store near Lake Balmorhea. On the way to the store, I noticed the flat hill that was pictured in *Gem Trails* just north of the road to the store. I asked the store operator about the blue agate, and he said it was out there, but hard to find. He had a beautiful cut piece on his windowsill about the size of a large fist. It had intricate, repeating bands of blue and gray, and it was quite striking. Unfortunately, I did not bother to take a photograph of it. As an optimist, I figured that we would soon pick up many such pieces.

Since that trip, if I ever get a chance to photograph a good specimen, I take the picture right away in case I don't get another chance or don't find anything remotely resembling the quality of such a piece. We went out looking in the washes south of the store near the lake, since these were easy to get to and were the most tempting. They were strewn with volcanic rocks and looked like the ideal place to find some nice agates. However, it was about 100 degrees and we could not walk very far. At the time, my kids were only 3 and 5, and while they could easily walk around the washes, we could not go very far from the car. I was also concerned we might encounter snakes or scorpions in the washes, but it was so hot that no living thing besides rock collectors was dumb enough to go into the sun. It was not long before my wife insisted we leave, and we did not have the chance to collect near the base of the flat hill seen in *Gem Trails*.

We came away without a single piece of blue agate. We later stopped at Toyah and got some yellowish-white agate, and that summer I also collected some agate and flint out by the Hueco Tanks area east of El Paso, which is listed in the *Rockhound's Guide to Texas*. However, I was still intrigued by the blue agate, and was convinced that we had not looked in the right spots.

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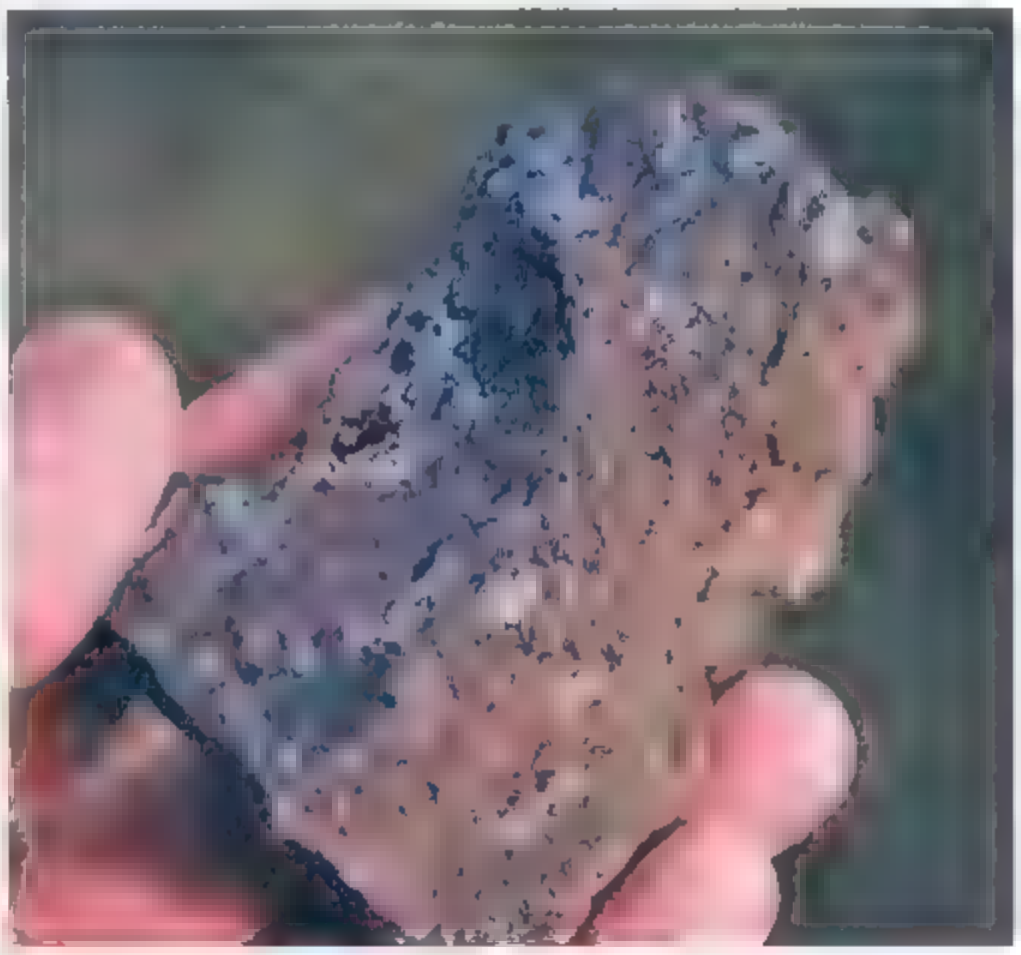


We found numerous nice pieces of brown basalt with crusts of light-blue agate.

I found the best way to spot the agate was to focus on the ground and look for pieces with a blue tint.

Balmorhea Blue *from page 61*

In early 2004, a member on one of the Internet groups I belong to (http://groups.yahoo.com/group/RockhoundsList) described the Balmorhea agate area, saying there was still quite a bit of agate to collect. His description indicated that one should focus one's collecting in the area from the hills on the north side of the road to the bottom of the dam and the surrounding flatland on the northeast side of the lake road. He said that a lot of people get sidetracked by the lake, but that was not where the agate is.

In early July 2004, my family was able to return to the site. We were returning from my niece's wedding, and were driving from Abilene to El Paso. We had two cars with eight people. The drive from Abilene to El Paso is pretty boring, so I was able to make a good case for stopping at Balmorhea. I said that this time our trip would be different, as now I had better directions for finding the blue agate.

We stopped at the lake store to purchase a use permit. The piece of blue agate I had seen back in 1999 was no longer there. I asked the young man operating the store if he knew anything about the blue agate. He said yes, some people still found some, but not many people asked about it. He showed me a small piece that they had outside the store, but it was much smaller than the original store agate, and it was not worthy of a photograph.

Unfortunately, we did not have a lot of time to work with. We drove back west on the highway to a pull-off that was just south of the main hill. This would be the area that we would hunt in, and the guidebooks and Internet group indicated that this was likely to be a good area.

We stopped at the shoulder and walked right into the collecting area. I had lots of collecting help, as I had my two children, my wife, and sister-in-law working the area. My mother-in-law, her sister, and another sister-in-law decided to stay by the car.

Since it was late afternoon, the heat was not too bad. We were lucky that no thunderstorms were threatening, as they can be very bad in this area. We walked on the flat area toward the hill, and like all rockhounds, gravitated toward climbing this hill. It is a relatively easy hike and with the summer heat we were not too scared of rattlesnakes, but I believe they could be a serious problem when the weather is a bit cooler.

We looked very hard in the area leading up to the hill, but did not find much agate. My daughter found a nice gray-blue piece about the size of a large marble, but we wanted some larger pieces. I soon found some sections of vesicular basalt that had vesicles filled with bluish-gray chalcedony. I hoped that we could find some larger pieces here.

continued on page 64

The flat desert floor makes for easy walking, and blue agates lie directly on the surface

As we climbed on the hill, I found several fracture fillings in the basalt with dark gray agate. I was not able to break these out, so I am not sure if they represented the blue agate when exposed to better light. However, we soon found numerous nice pieces with crusts of light-blue agate. We could often see a bubbly texture to the agate when we looked closely. The blue contrasted nicely with the brown of the basalt.

The best blue agate appears to have formed on weathered surfaces. I found the best way to spot the agate was to focus on the ground and look for pieces with a blue tint. When I found a piece that had some blue agate, I would use my hammer and chisel to trim the barren sections away. I broke apart many rocks, hoping I would find some good agate on fractures, but the freshly broken pieces almost always showed only brown volcanic rock.

Unfortunately, like with many of my collecting trips with my family, we had to cut things short. We had found some interesting pieces, but I think it would have been much better to take more time and explore the areas away from the main hill. I am sure that this area has been picked over pretty well, and exploring some of the areas that are harder to get to might prove productive. Although we did not find any large agates, the next people to collect may have much better luck, especially if they invest a little more time and effort.

While doing some follow-up research for this article, I obtained a copy of the latest revised edition of *Gem Trails of Texas*, by Brad L. Cross (2001, Gem Guides Book Co.). This edition describes the Balmorhea site in additional detail, and describes the collecting areas as all along the northeastern side of Lake Balmorhea. This latest edition of *Gem Trails* also has a nice color picture of rough and polished Balmorhea agate. Not surprisingly, it was far superior to what we found in our brief collecting at the site, and it shows what to look for when you are watching the ground for blue agate.

To get to the site, follow state Route 290 from I-10 to Balmorhea. State Route 290 becomes S. Main Street in Balmorhea. Turn to the southeast on Houston Street, which becomes state Route 315. You will soon see Lake Balmorhea on your right (southwest), and a flat hill that is topped with brown volcanic rocks to your left. The area just southeast of the flat hill is reportedly where the best collecting is found. Continue on the road, and you will come to a small development with a grocery store. This is where you pay for the use permit. After that, you are free to go wander the washes and the hills. Swimming is not allowed in the lake, and pets must be kept on leash, but there are no restrictions on rock collecting.

During the summertime, the area often gets extremely hot, and thunderstorms with lightning can appear suddenly. Fortunately, nearly all of the collecting can be done within a short walk from your car, so it is easy to cool down or get out of the storm path quickly. Personally, after enduring many brutal winters and much cold, rainy collecting in the Northeast, I find walking around in the desert heat of West Texas very pleasant. As long as you use common sense when collecting with your family, the summer heat should not be a problem.

Although this area definitely qualifies as a heavily collected site, there is still good blue agate to be found. Allow yourself at least an hour or two to do collecting near the base of the flat volcanic hill and the area to the northeast, and you should find some nice blue agate. I have never seen a blue agate like this anywhere else, and it is a nice addition to any collection.

ORGANIZE through

Use recycled cardboard flats and other materials to transport and display items for sale at rock shows.

Cardboard Flats Have Many Uses

Story and Photos by Larry G. Field

Where is the spare arbor nut for your slab saw? Can you show me the best grade of Lake Superior agate you have for sale or trade? Where is the owner's manual for your facet machine so we can look up the refractive index for sunstone? Do you have any belemnites from the Jurassic Swift formation? Can you answer these questions? Can you take me directly to these items if you have them? If your collection and hobby shop aren't that well organized, you should read on and learn how to become organized while protecting our environment through the recycling of potential waste materials.

Nearly anything of a standardized size can, perhaps even should, be recycled. Standardized sizes make it possible for you to design uses that can be applied to many jobs without having to invest time and labor in changing the shape or size of the item prior to utilizing it. Useful standardized items include soft drink boxes (flats), milk boxes, coffee cans, flat tuna and pet food cans, soap cans, newspapers, etc. I will focus on flats in this article because they are an item that most rock hobbyists already recycle, but perhaps not to the degree possible.

Flats are a rock hobbyist's best friend. A book could be written on their uses. In my hometown of Billings, Montana, one of the soft drink dealers recycles empty flats by making them readily available for hobbyists such as rockhounds and gardeners. It charges 3 cents per flat and donates the generated income to charitable causes. This helps the environment by recycling, it makes flats available for hobbyists, and the money helps the needy.

Flats can be used in pairs as a box and lid. I normally acquire 300 at a time. At home, I begin by pairing them into flat-and-lid combinations. Then I paint

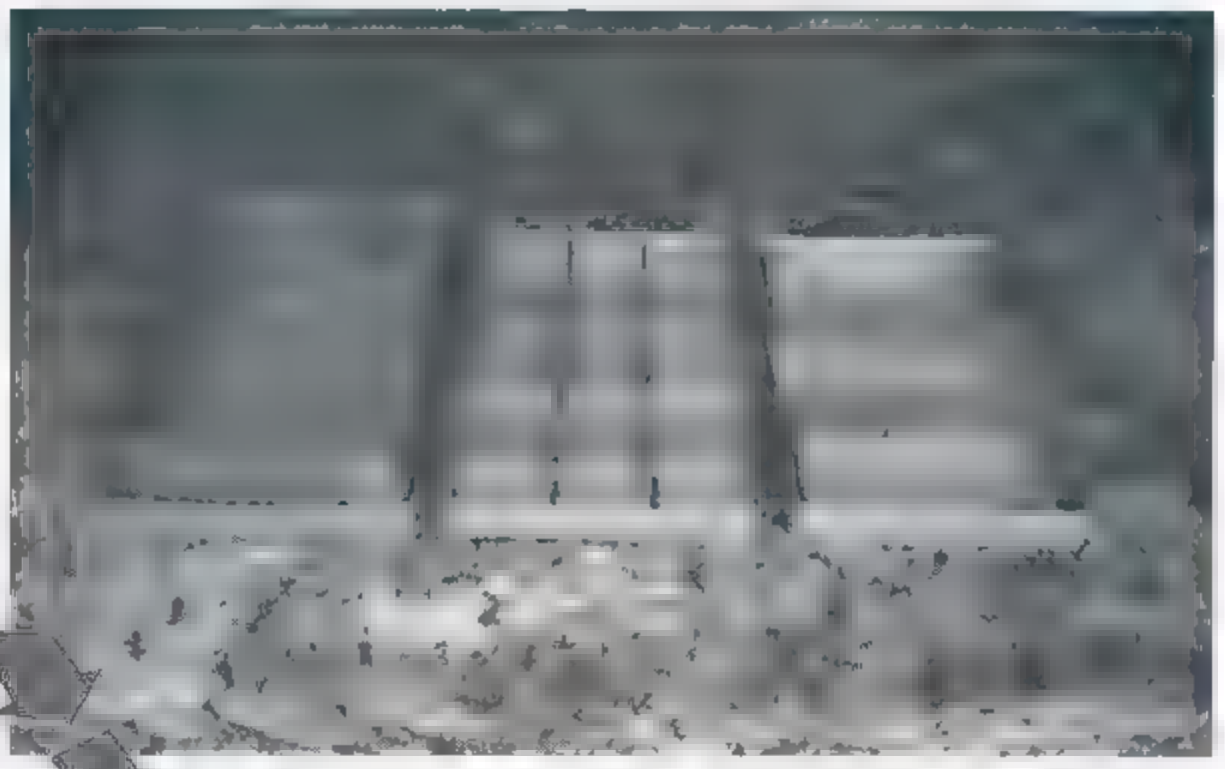
RECYCLING

the sides and ends of the lid. The white paint can be written on to identify the contents. The paired, painted flats are then stored nigh in my pole barn until needed.

The bottom inside of a flat is 15.5 inches by 10.25 inches. The flat wall is 2 inches tall. By cutting cardboard into 2-inch by 15.5-inch and 2 inch by 10.25 inch strips, you can partition the box into however many cells are needed for a project. This "partitioning" technique works well for dividing the box into four or more cells.

For example, when I speak to schools, I usually donate collections of 12 specimens each. Therefore, I partition the box with two long partitions and three cross partitions, creating 12 cells to hold the collection.

To divide the box into two or three cells, either crosswise or lengthwise, cut long strips of cardboard, place the center of the strip where you want your partition to be, and fold the ends of the strips back where they touch the box walls so the extra cardboard extends to the corners of the box. Staple the ends of the strips to the sides of the boxes.



For storing bulk material, you can add sideboards or partitions to flats to meet your specific storage needs.

Standard-size materials like milk cartons or tuna and soup cans fit easily into flats to hold small specimens or lapidary supplies.

TRANSPORTATION AND DISPLAY

If the boxes are for storing small specimens, you can put containers inside the flats. For example, to display cabs in a flat at a rock show, spray paint the inside edges of the flat to improve its appearance and add jewelry boxes as containers for the cabs. If the storage is for backlog in your shop, use tuna or soup cans. Soup cans are the same size as soft drink cans, and will fit the flat perfectly. If you're using the flat as a display at a rock show, during setup, place the box half in the lid half, with the end away from the viewer propped on the edge of the lid to hold the display at an angle for easy viewing. One can also place strips of 1-inch polystyrene under one end to add slope.

If the flat is not deep enough for the desired use, add sideboards. Do so by cutting a piece of cardboard 50 inches long by the height needed. I normally consider 4 inches to be the minimum height for this purpose. Take the 50-inch by 4-inch cardboard sideboard and score it by cutting halfway through the cardboard at 15 inches, 25 inches, and 40 inches. Fold at the scores so the sideboard will fit into the flat, and tape the loose ends of the sideboard together. When taping, run the tape about 1 inch above the sideboard and fold it over to the inside. That will keep the lid from catching on the tape and pulling it free. Use a second flat on top of the sideboards as a lid. If the sideboards aren't 4 inches high, the two flats will rest on one another and one will have to be trimmed down so the lid rests on the sideboard.

If the contents of the flat are so heavy that the box collapses, reinforce it by adding a 15.5-inch by 10.25-inch sheet or two of cardboard to the floor of the box. If it is still too weak, add a sheet of ¼-inch plywood or some other recycled, flat construction material of the same size.

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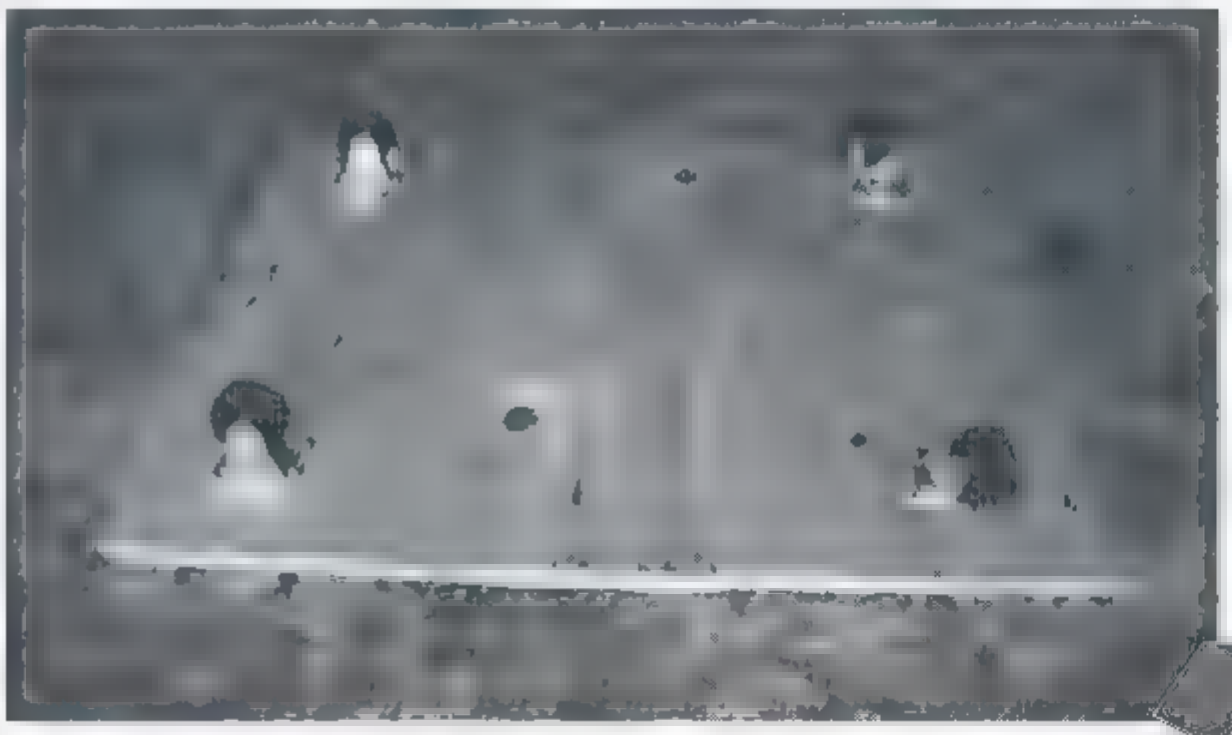
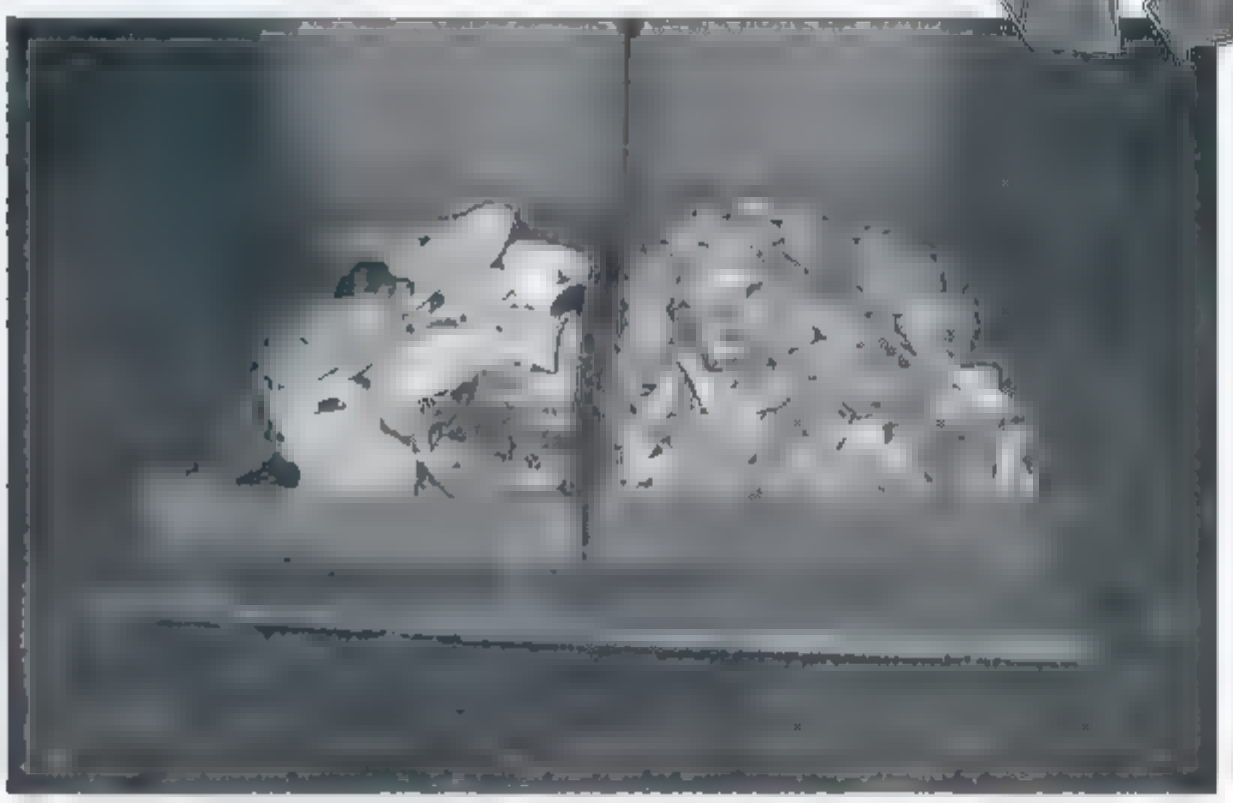
Organize through Recycling *from page 67*



Make an "ore cart" to move and store your filled flats out of a square of plywood and some casters. Use fixed casters on one side and swivel on the other for ease of positioning.



Size the ore carts so hold two stacks of whatever type of storage units you are using (flats, cardboard boxes, etc.). Paint and label the ends of the boxes so you can locate items without opening every box.

Items such as chains, necklaces, key rings, bead strands, and pearls may be displayed in flats. Spray paint the flat to improve its appearance. Place a sheet of ¼-inch plywood in the bottom. Insert a dowel or screw hooks into the plywood to serve as hangers. I like to drill the plywood at 1-inch intervals and insert old golf tees. Short strands may be hung widthwise in the flat, and long strands may be hang lengthwise.

Flat bottoms can be lined with molded "waffle" foam for displaying specimens such as marbles, fossils and minerals. Polystyrene, carpet, carpet pad, or foam can be used in the bottom of the flat to cushion the specimens from underneath. Foam sheets can be added on top and compressed by the lid to secure the items stored in containers and prevent them from coming out or shifting position.

BULK STORAGE

In the rock storage area of your shop, you can use undivided flats for storing bulk rock or divided flats for storing smaller or sorted pieces. In your "sales" area, you can use flats that you have dressed up for presentation to store your sales items. In your work area, you can mark one flat for each of your tools and keep the owner's manual, service records, tools, accessories, spare parts, and any other item specific to that tool in its flat. Store all your flats in alphabetical order by contents, and you can now locate that Lake Superior agate, belemnite, arbor nut, or refractive index.

MOVING AND STORING FLATS

I have built many items for handling flats. I have a dolly, wheeled storage racks, stationary storage shelves, "ore carts," and storage sheds designed to hold flats.

I have built many items for handling flats, including a dolly, wheeled storage racks stationary storage shelves, and storage sheds

Since all are easy to make, I will be brief with my construction details. The main decision one should make prior to cutting materials is whether you wish to use your items strictly for flats or to accommodate photocopy paper boxes, another standard sized box that is of great value to hobbyists.

When building storage shelves, you should consider the shelf spacing. The greater the space between shelves, the greater the weight each shelf will hold, and therefore stronger construction will be needed. Also, the greater the spacing, the higher you will stack your flats on each shelf, and the more flats you may have to move to access the flat on the bottom of the stack. Finally, consider my 75 percent rule. If storing bulk rock in a flat, use only 75 percent of the space available so you can add or remove material without having to rearrange the entire pile of flats. Fill each shelf only 75 percent full so you can rearrange the flats on the shelf and add or remove flats without having to rearrange the entire storage area. Leave room so you can add or subtract with minimal effort.

Each time you recycle flats, scraps of polystyrene, foam, carpet, etc., think to yourself, "I just saved a tree." Become so accomplished at recycling that you will think beyond your own trash can. Keep your eyes open for recyclable cardboard flats around construction projects. Always ask before you take anything, but you can frequently hit a bonanza. Help protect our environment through recycling. If you have an idea but don't have the ingenuity needed to bring it to fruition, bring it up at your next rock club meeting. Someone will be able to help!

Rock Science

by Steve Voynick

Solving the Riddle of South Africa's Gold

South Africa has produced 40 per cent of all the gold ever mined on Earth, far more than any other nation or region. Virtually all of South Africa's gold has come from the gold-bearing reefs of the Witwatersrand Basin. Geologically unique, these reefs consist of superposed strata of coarse, highly metamorphosed conglomerate rock composed primarily of quartz and chert pebbles in a consolidated matrix of fine bits of quartz sand, other silicates, and pyrite. On average, the reefs contain about 1 troy ounce of gold per ton, although actual grades vary from as little as troy ounce to as many as 20 troy ounces per ton.

Since the Witwatersrand reefs were discovered in 1886, geologists have hotly debated whether their origin was due to placer deposition or hydrothermal emplacement.

Initially, most geologists stood behind the theory of placer origin, believing that large, ancient rivers had washed enormous quantities of sediments into an inland sea that once covered what is now central South Africa. These sediments were intermittently rich in gold, which concentrated in broad deltaic and sea-bottom placers. After subsequent deep burial and metamorphism, the gold-rich layers formed the superposed gold-bearing reefs that are mined today.

Supporters of the hydrothermal model of origin believed that great pressures forced superheated, mineral-rich hydrothermal solutions upwards to permeate existing sediments and emplace the gold. According to this theory, gold-rich solutions rose in columns, then spread laterally through layers of more porous strata to emplace the gold in horizontal reefs in a manner that mimicked massive placer deposition.

Because of intense metamorphism, the physical nature of the gold particles gave no clue to their origin. Geochemically or radiometrically determining the ages of both the gold and its matrix rock was the only way to solve this riddle. Dating the matrix rock was the easy part, and existing radiometric technology established its age at about 2.75 billion years.

But no technology existed for dating the gold itself until recently, when an international team of geologists and geochemists working at the University of Arizona designed and built a Negative Thermal Ionization Mass Spectrometer (NTIMS). This new spectrometer is capable of detecting and measuring the amounts of rhenium and osmium that are present in gold in traces ranging from parts per million to parts per billion.

The rare metallic element rhenium has a radioactive isotope, rhenium-187, which eventually decays to osmium-187. The half-life of this decay is 45 billion years, or about 10 times the age of our solar system. NTIMS literally counts individual atoms of both the rhenium and the osmium isotopes. By determining the ratio of these two types of atomic isotopes within a tiny gold sample, researchers can directly calculate when the gold originated.

The NTIMS teams concluded that Witwatersrand gold is about 3 billion years old, some 250 million years older than its host rock. This discovery confirms that the Witwatersrand gold-bearing reefs did indeed originate as massive placers, with the gold first forming in distant, older rocks, then being alluvially transported into the younger sediments.

University of Arizona geologist Jason Kirk explains how the NTIMS data also provides additional insight into the origin of the Witwatersrand gold. He notes that the Earth's crust contains considerably more rhenium than osmium, a ratio that is reversed in the underlying mantle.

"The NTIMS rhenium-osmium ratio data can therefore also tell us whether the gold originated in the crust or in the mantle," Kirk says, "and this gold shows a clear mantle signature."

This means that Witwatersrand gold was actually first emplaced far back in the Earth's history when tectonic plates were just emerging. The gold formed in rocks some 3 billion years ago when the upwelling mantle created the ancient Kaapvaal Craton, a major section of the South African continental crust. This unique geological formation originated directly from the mantle and explains why the Witswatersrand reefs are richer in gold than any other known deposit, and why Witwatersrand gold is the oldest gold ever mined.

LAPIDARY LORE AND MORE

Memories

by June Culp Zeitner

The best thing about getting old is the wonderful memories of long-gone days. Back in the 1930s and '40s, most mineral, gem and fossil enthusiasts knew each other. It was like a big family with relatives scattered all over.

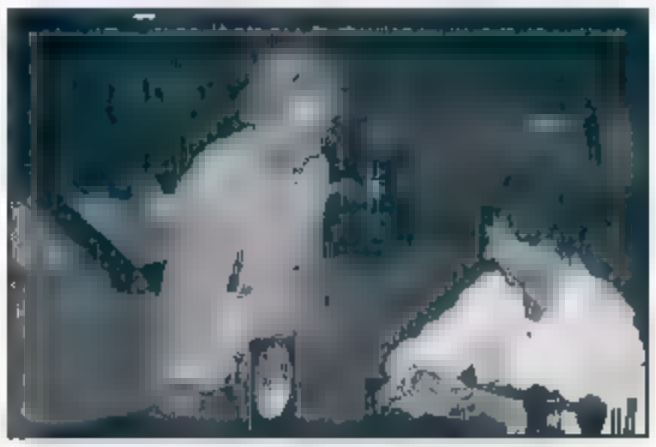
I remember when Albert and I first started our 30-year safari. We pulled our "Tipi Omani" (house that travels) with our Chrysler straight eight, named Lochinvar for its Scotch plaid interior. We stopped for lunch at a wayside park in Oklahoma. Another vehicle was parked there, a Buick from Pennsylvania. The lady got out of the car and ran toward us calling out, "I bet you are the Zeitners and this is Tipi Omani and Lochinvar." Small world.

One winter, while staying in Fort Myers, Florida, we went to the little-visited Pine Island. A man was combing the beach for shells. He said his name was Waldo Jones. I had read articles by him in the *Mineralogist*. We were surprised and happy to find several fossil horse teeth. He found a rare sinistral (left-hand) shell. A. took a picture of us with our prizes. Small world.

Once, I took a plane from Harlingen, Texas, to South Dakota. The flight stopped at Dallas. A man entered the plane and took the seat behind me. He said he owned a plastics factory. After telling me he was headed for California, he said he was going to visit a friend, Hugh Leiper. I told him I, too, was a friend of Hugh's and wrote for his magazine, *Lapidary Journal*. He said, "You must be June Zeitner." Small world.

If we didn't know the fellow enthusiasts personally, we knew them through correspondence. Everyone wrote letters in those days. I wrote to a man named B.H. Beane, who spent his days collecting marine fossils from a quarry in Le Grand, Iowa. I asked him if he would sell me a crinoid specimen. He sent me a piece of limestone with five species of crinoids on it. He wrote to me when he found fossil starfish. Once in a while, he would send me a clipping about a new find. He was given an honorary doctorate and his collection was housed at the Capitol in Des Moines.

Shortly before we closed our museum in Mission, a young man walked in. "My grandfather came to see you," he announced. "Is now a good time?" I assured him I would welcome a visit. He went out to his car and helped the old man into my rock and gift shop. It was Dr. Beane. We had an unforgettable day.



Rockhounds are like a big family with relatives scattered all over.

Fellow collectors and collecting sites fill my memories.

Two of my correspondents were crippled and bed-bound. Henry Lajoma of Ahmeek, Michigan, and Curly Washachek of Long Pine, Nebraska. Neither ever complained about his handicap. They were too busy cutting slabs and cabochons and making money with their enjoyable hobby. Both earned enough money to pay for their equipment and gem rough and make a moderate profit.

One year, the AFMS show was in Fort Worth. I was invited to give two programs. I had a letter from my manufacturing acquaintance and his wife in Dallas inviting me and a dear friend who was also on the program to a party in our honor at his lakeside home the evening before the first day of the show. The lakeside home – I should say castle – was surrounded by an endless garden. The trees twinkled with golden lights. 12 tables for eight or 10 were spread near the shore, each with linen, silver, glass, and flowers. A festive booth was occupied by a bartender, making drinks to order. In another part of the garden, a Mexican bar was busy serving margaritas and corn chips.

I was at the latter bar with a frosty drink when my 45-year old friend arrived. Her plane had been late. She hadn't eaten all day and eagerly took a margarita with a taco, then suddenly fell flat on the grass in a deep faint. Two gentlemen carried her into the house and put her in a downstairs bedroom. In a few minutes, she came to. She studied the well-appointed bedroom where she lay and asked the inevitable question, "Where am I?"

"You're in a private bedroom. Just be quiet. You'll be better soon," answered the tall grey-haired man.

"Who are you?" she asked.

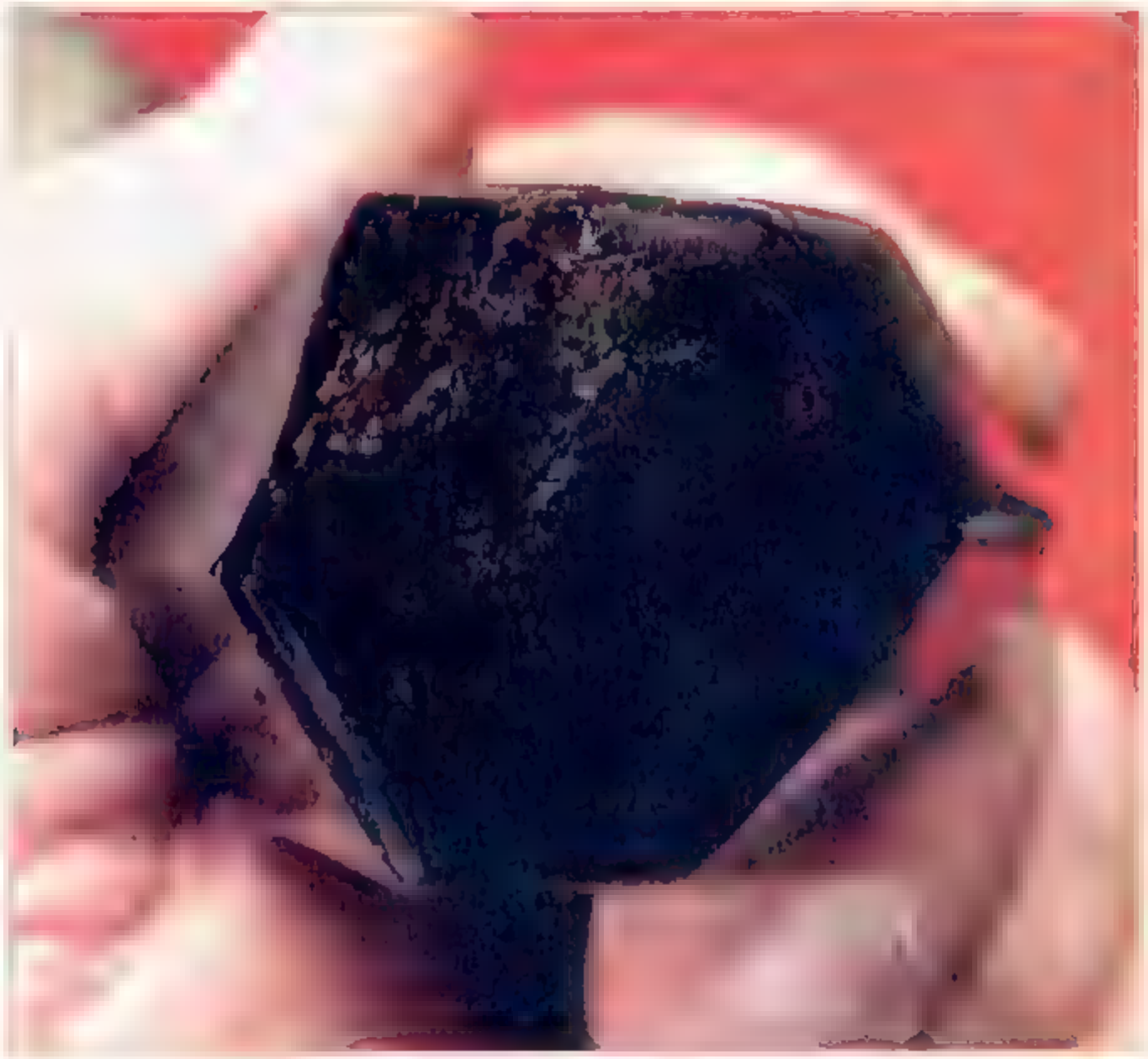
"I'm Dr. Howell. I'm an obstetrician," the man replied, whereupon my friend almost fainted again.

A bad thing about being enthusiastic at the sign of gemstones just waiting to be picked up is that the finder tends to forget landmarks and directions. Albert and I had gone to a new collecting area on the Arizona-California border. We had asked the Olsons, from Mankato, Minnesota, to come with us. The minute we stopped, Albert, followed by the Olsons, headed toward a hill with several ledges that could be productive. I spotted some iridescent apache tears and started filling my bag, a newspaper boy's canvas bag. After a while, I looked up and found I had wandered to a desolate country road. I was in a Joshua tree forest. I called as loudly as I could, but got no answer. I became panicky and decided the only way to spot the others was to climb a Joshua tree. It was ouch, ouch, ouch! Then I fell into the hard, pebbly sand. I let out a scream of defeat. No answer! It was almost time for everyone to meet at the car. What car? Where? Like a true rockhound, I called an excited, "Look! Look! Look!" There was an immediate answer, "Where?"

I followed the voices over a slight rise. "I'm here," I called. I should have guessed the response. "Oh. So it's just you."

FIELD TRIP

The Little Pine Garnet Mine



The lucky collector will find a dark reddish-black garnet crystal. Though not facet grade material, they take a good polish.

Western North Carolina Produces Large, Well-Formed Crystals

Story and Photos by Richard J. Jacquot

This well-formed garnet crystal weighs 5 pounds It now resides in the Henderson County Mineral and Lapidary Museum.

This almandine garnet crystal, partially replaced by chlorite and iron, in matrix is an excellent example of the material found at the mine Left: The mine entrance is the only shaft that remains open to collectors.

I have been an avid rock and mineral collector all my life, but a move to Western North Carolina in 1987 opened the door to a whole new world of collecting possibilities. North Carolina is famous for the variety of gems and minerals found in abundance throughout the state. tourists flock to the area annually to visit the numerous gem mines in the Franklin, Hiddenite, and Spruce Pine areas.

As a specimen collector myself, I have always had a passion for large, well-formed crystal specimens. The pegmatites in Western North Carolina are also famous for producing some of the largest mica and feldspar crystals in the world, along with byproducts such as beryl, garnet, tourmaline, apatite, kyanite, and much more. I spend much of my time searching for the old and abandoned pegmatite mines hidden in the mountains that have produced these crystals in the past.

The Little Pine Garnet Mine is located in Madison County near the town of Marshall. This site had been mined in 1904-05 for abrasive garnet for industry. The mine consists of several shafts located on a hillside a few hundred yards above Little Pine Creek. All the shafts have been filled in and fenced off except for one at the top of the hill. It is a horizontal shaft approximately 150 feet deep. The Little Pine matrix material is a metamorphic rock composed of a chlorite-mica schist containing quartz, iron and almandine garnet. Geologists theorize that three mountain-building stages formed the Western North Carolina mountains and that the garnet crystals found at the Little Pine Mine were formed during the first stage.

My experience with the Little Pine Garnet Mine began over 15 years ago. While visiting a friend and viewing his collection, I noticed several large garnet crystals — some as large as baseballs — sitting on his shelf. The crystals were well-formed, 12-sided almandine garnets partially replaced with chlorite. Being the large-crystal "nut" that I am, I had to know where he found them. I was pleasantly suprised to find out that the site was open to collecting for a small fee, and even more surprised to learn that it was only a 15 minute drive from my home.

My friend provided me with a map to the mine and the contact information I would need. Two days later, I was traveling the back roads of Madison County to the site. The directions were precise and led me to the home of the owner of the mine, Jack Ball Sr. At the time, Jack was in his mid 70's. I paid $5 for a day of collecting, and asked for directions to the mine and what I should look for. Jack brought out several specimens he kept at the house to show me.

For me, the rockhounding hobby is not just about collecting the specimens, but also about learning the history of the mines and locations where the specimens are found. Jack must have sensed my interest to learn more about his mine. He invited me into his home and started off by showing me the difference between what he called "sugar garnets" and the gem-grade garnets. The sugar garnets (garnets mostly replaced by chlorite) were discarded on the dumps at the mine as unsuitable for either gems or even abrasive material. (Nongem garnet is sometimes used in sandpaper or on grinding wheels.)

The better quality garnets are deep red to almost black in color. "These are the ones you want" Jack said, holding up one of the dark, well-formed crystals to the light. He then began to tell me a personal history of the mine that I would not find in old mining reports.

Jack's father, Logan Ball, had purchased the Little Pine Mine in 1913. Industrial mining for abrasive garnet had been discontinued at the site years before and the mine had sat idle for several years. Logan saw potential for gem garnet in some of the crystals he had been finding and had contacted Tiffany's of New York about possibly leasing the property from him. Tiffany's asked him to send some samples of the gem-grade garnet to them. Now most folks would have boxed up a nice selection of garnet crystals, mailed them to New York, and hoped for the best, but not Logan. He loaded the trunk of his car with gem-grade garnet crystals, and he and his brother drove to New York to deliver them in person.

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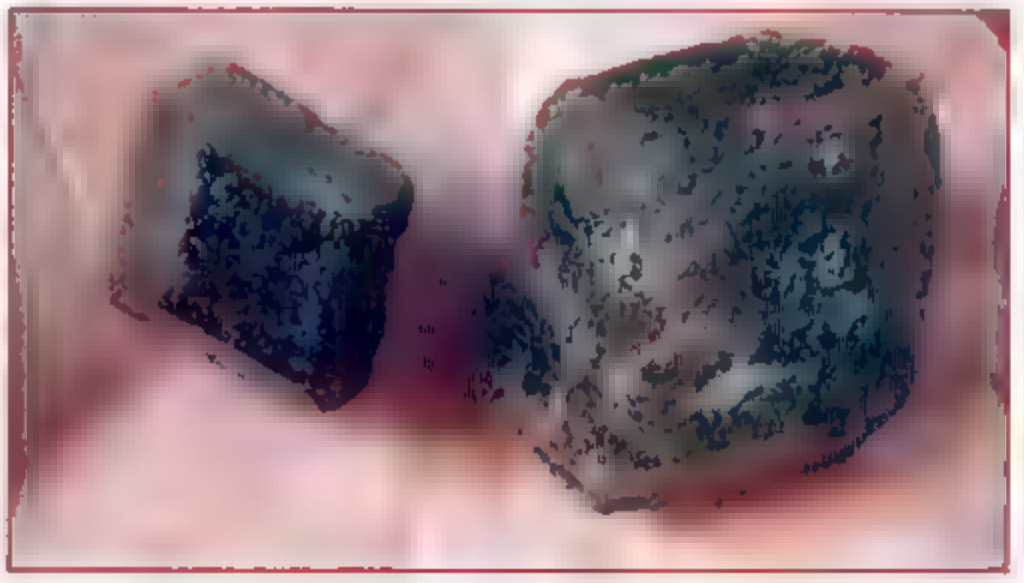
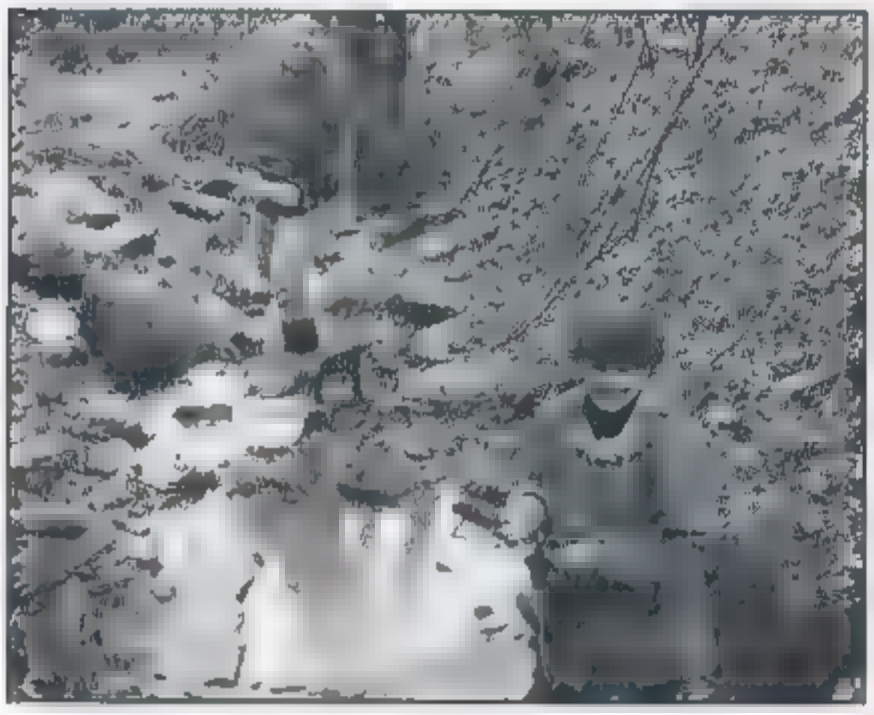


These reddish-black almandine garnet crystals were recovered from the floor of the mine



Collectors can also dig and sift the gravel in the creek below the mine to recover discarded garnets.

Jack said Tiffany's was impressed with the quality of the garnets and did eventually send a representative to North Carolina to inspect the site. Unfortunately, after a thorough inspection, it was decided that there was not enough gem material available in the mine to justify commercial operations, and no lease agreement was reached. In the following years, Jack said, several small-scale mining operations took place. Abrasive garnet, gem garnet and even soapstone were recovered, but never enough to justify continued operations. Eventually, the mine was closed for good. Jack told me how, as children, he and his friends would play near the mine on the dump piles. He said they would roll garnet crystals, some as large as bowling balls, down the hill into the creek below!

Jack said his father eventually began allowing local collectors to collect at the site for a fee. Word got out about the huge, well-formed crystals to be found, and the Little Pine Garnet Mine soon became a favorite collecting site for rockhounds from all over the country.

You can imagine that, after sitting and hearing the stories of beautiful gemstones and large garnet crystals, I was more than anxious to get up to the mine and get started. Over the next several years, the Little Pine Mine became one of my favorite places to collect. Whenever I spent a day collecting, I would always stop by to see Jack on the way home and show him what I had found. He always enjoyed seeing the crystals. Over the years, I have accumulated quite a collection of these garnets.

There are a couple of techniques for collecting at the Little Pine Mine. You can dig in the creek gravel across from the entrance to the mine or in the dump piles that surround the hills de near the mine to recover the loose crystals that have been discarded, or you can bring your hardhat, headlamp, hammer, chisels, and safety glasses and go inside the mine to collect. I prefer to collect inside the mine to expose new material. It is always a thrill to be the first human to see a crystal that has been hidden for millions of years in its matrix bed. You can find 12-sided almandine garnets from ¼ inch up to 5 and 6 inches in diameter.

Use your hammer and chisel to remove some of the chlorite-mica schist to expose the typical flat faces that will reveal a garnet crystal. Try not to chisel too close to the crystal when removing it from the matrix rock, or you'll put pressure on the crystal, causing it to break. Most of the crystals found will have excellent shape, but they are being replaced by chlorite, which makes them too brittle for cutting or polishing. On occasion, you will find a nice dark reddish-black crystal that will take a nice polish, and rarely, a facet-grade piece can be found.

This mine is also noted for its unusual elongated crystals, twins and triplets. These make great cabinet specimens. I have talked with several geologists and mineralogists about the elongated crystals. Some believe that pressure exerted on the crystals while they were forming caused them to distort into this shape. Others think it is simply due to the atomic makeup of the crystals, and that heat or pressure played no part in the unusual shapes. Whatever the cause, the crystals make very nice specimens, and this is the only location I have ever heard of that these crystals form.

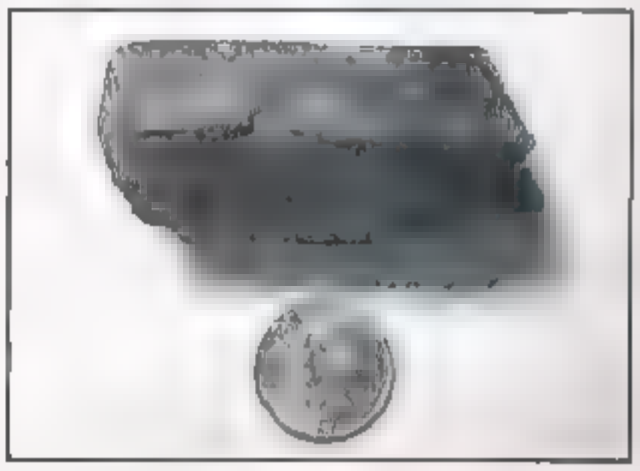
Most collectors will try to remove the Little Pine Mine garnets with matrix attached. Leaving them in matrix is preferable, since some of the garnets are brittle and break easily while you are trying to remove them. I prefer to find a crystal that is solid enough to be removed intact, showing the whole crystal. Only hand tools are permitted at this site, which should keep it productive for the next hundred years. Of all the sites I have visited and collected at in Western North Carolina, the Little Pine Mine has been the most productive and enjoyable because of the abundance of material to be found. It is the first site I recommend to new rockhounds so they won't be discouraged.

Over the years, many changes have taken place at the mine. Jack, now getting close to 90 years old, has turned the site over to his son, Jack Bell Jr. Like his father, Jackie has a great relationship with us rockhounds. He has added a portable toilet to the site, as well as picnic tables and trash cans. Jackie also owns and operates Sandy Bottom Trail Rides, a horseback tour business that features a stop at the garnet mine for the riders. When I am collecting in the mine, I always try to set aside some garnet crystals to give to the riders as a souvenir. For more information about the trail rides, visit Jackie's Web site, www.sandybottomtrailridesnet.

I try to get to the mine at least once a month to collect, and after more than 15 years, I still come home well satisfied with my finds. In my guidebook *Rock, Gem and Mineral Collecting Sites in Western North Carolina*, (Lightning Source Inc., 2003) the Little Pine Garnet Mine is the first site listed. More recently, the mine was featured in a video about mineral collecting sites and the mining history of Western North Carolina. Volume One of the ongoing video/DVD series was released in January 2005. (For more information on the video and book, visit www.wnerocks.com.)

While conducting research and filming at the mine in the spring and summer of 2004, I, along with my friend Tim Barton, recovered one of the largest crystals to come from the mine in many years. It weighs just over 8 pounds and now resides in the Tim Barton collection. From the same pocket, I removed more than 100 garnets weighing between 1 and 8 pounds. Whether you are new to rockhounding in Western North Carolina or an old rockhound like me, there is no better place to visit than the Little Pine Garnet Mine.

Directions: From Asheville, North Carolina, follow Interstate 26 West to the U.S. Highway 25/70 Marshall exit. Travel toward Marshall on Hwy. 25/70 for 12.5 miles, then turn left onto Little Pine Road. Travel 4.2 miles to Roberts Branch Road, turn left, and travel 0.4 miles to a gravel drive on the left. Follow the drive across the creek and park in the open parking area. Hike up the road to the left (east) approximately 250 yards to the mine, which is at the top of the hill and on the right.

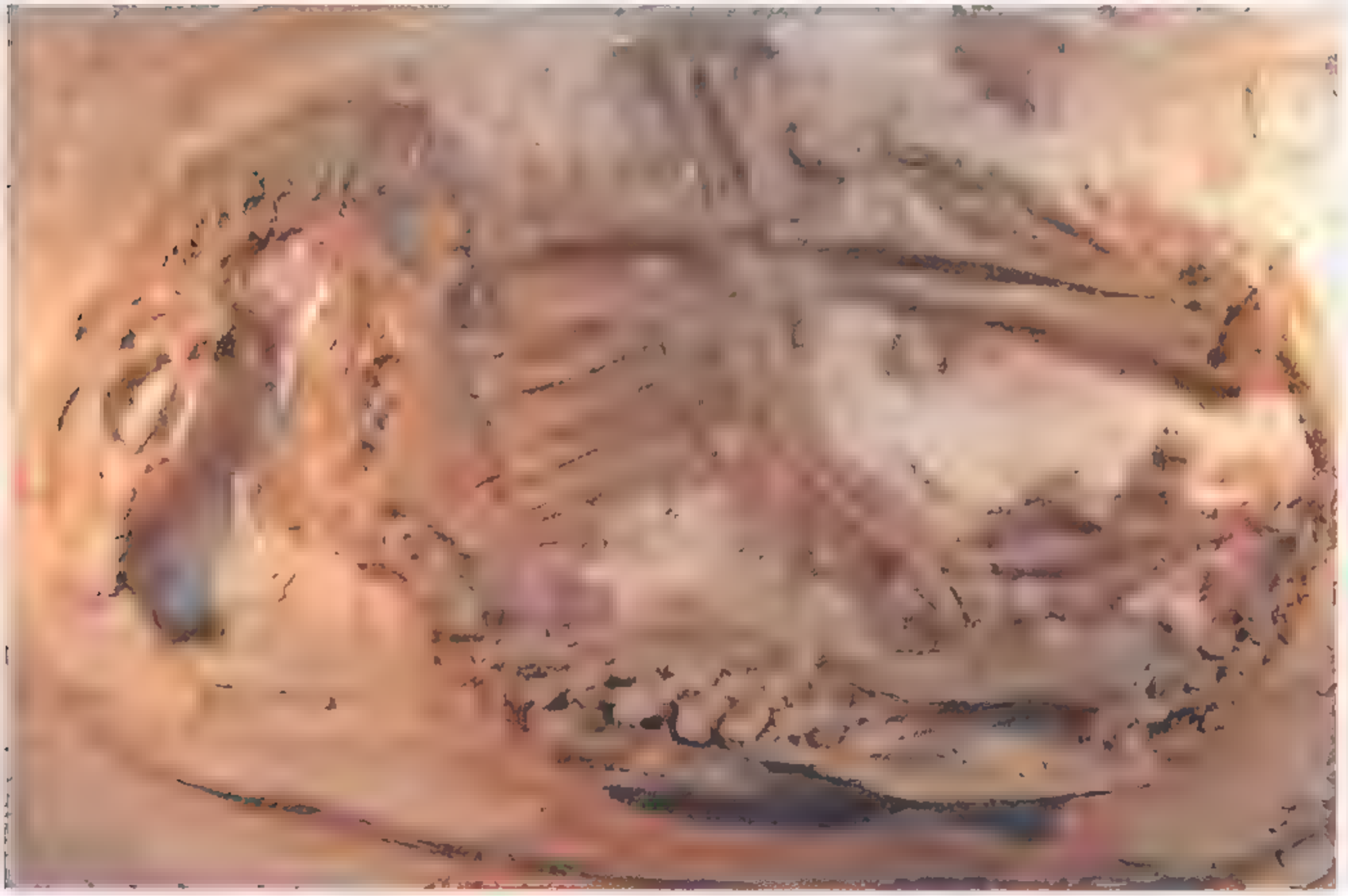


Some theorize that great pressure caused these unique elongated garnet crystals to form

Dinosaurs across CHINA

The Fossil Beds of this Great Land Have Hardly Been Tapped

Story and Photos by Timothy Huang



An excellently preserved Jehosaurus resides in the DaLian Natural Museum. The museum has insufficient room to store all its feathered dinosaur fossils, so some lie on the floor of its warehouse

Recently, I had a great chance to accompany a good American friend of mine to visit several famous Chinese dinosaur sites, from the very northeast to the very southwest corner of China. We saw so many great Chinese dinosaurs and sites. I wrote this article as a personal record, as well as to share with you.

China is a big dinosaur country, although from the point of view of discovered and studied results, it is not as famous as America. Americans, however, have already been digging

When the Chinese people do not have enough to eat, why should they care about dinosaur bones like this Omeisaurus specimen?

dinosaurs for more than 100 years, and with such a big and rich land with so many scholars, her dinosaurs are well known throughout the world. In contrast, for the past 100 years or so, China has not been in the best condition. Many people do not even have enough to eat; why would they care about dinosaurs? If they did not grind up the dinosaur bones for medicinal purposes, it is considered a blessing.

However, even under such unfavorable social conditions, there are those who dedicate themselves to the study of dinosaurs. For example, under the very hard conditions of fighting the Japanese before and during World War II, Professor C.C. Yang became the founding father of Chinese paleontology. In 1938, he found the very first Chinese dinosaur that was excavated and studied by the Chinese, the Lufengosaurus huenei of LuFeng County, Yunnan, along the famous Burma Highway. Following the Open and Improvement Policy of mainland China, the economy was improved significantly. So in recent years, more people have become devoted to this "fringe" science of paleontology, with some spectacular results and discoveries, such as the ChengJiang Cambrian Explosion and the LiaoXi feathered dinosaurs. These are the biggest and the most important discoveries in the world. These fossils changed our view and understanding of the evolution of life.

After these many years of research by these scholars, we can say that every province of China has some dinosaurs, except Taiwan. And speaking from the number of species, Chinese dinosaur fossils are the best in the world in quantity and quality. For many years now, I have really wanted to visit these major dinosaur areas as a pilgrim to fulfill my lifetime dream. For many years, I was not able to do so due to the constraints of time, money, and public relations; in China, you must have a "relationship" established with someone to do things easily. It is very difficult to make such a trip. But now, a chance opened up. How could I miss it?

Pit #1 at the ChuanJie Dinosaur Graveyard exhibits a wealth of specimens that is common to many sites across China.

The discovery of the LiaoXi feathered dinosaurs changed our view and understanding of the evolution of life.

I went accompanied by a good American friend. Our first stop was the DaLian Natural History Museum. It was established by the Japanese back in 1907, so it is a surprise to know that it even has hokutolite, a mineral found in Taiwan in 1905, while it was under Japanese occupation, in its collection. Of course, it may be from the efforts of the current energetic director that they have such a rich collection. For example, if another museum has one feathered dinosaur, even just a lousy one, it will be very proud. However, in the DaLian Natural History Museum, there are so many feathered dinosaurs that they had run out of room to put them. Some were just lying on the floor in the museum's warehouse, while a number of the bird fossils were piled in a corner.

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The most interesting item in the collection is a nest of Psittacosaurus, which contains an adult and 34 babies measuring less than 20 centimeters. The posture of each one is so lively, unlike the common death pose of dinosaurs. This is a real rare sight in the world. It is also a very important specimen for scientific studies. I have had the good luck to see it with my own eyes; better still, I even had the chance to prepare it last year.

After we saw the rich collections of this beautiful seaside museum, a staff member, Mr. Liu, took us to the western part of LiaoNing Province, also called the LiaoXi area, to get a personal taste of this world-famous fossil area. We took the train six hours from DaLian to JinZhou. Through a local arrangement, we went to SiHeTun to see the cross section of the YiXian Formation. The guide there pointed to the wall and said, "From that layer [came] the big fish [more than 1 meter long] Protopsephurus liui, from that [came] the insect fossils, and from that [came] the oldest flowering plant [Archaefructus liaoningensis], and [from] over there [came] the birds [Confuciusornis sanctus], and from that [came] the Psittacosaurus, and from that [came] the feathered dinosaurs (Sinornithosaurus) ...."

My brain almost exploded from taking in such a huge amount of information in such a short period of time. Just from such a small place, many world-shocking fossils were recovered. Nobody really knows how many places like SiHeTun are in the whole LiaoXi area. After we walked out of the exhibition hall, without any tools in hand, we just flipped and kicked the dump rock over. Within several minutes, we had found more plant and insect fossils than we could carry home. I learned about the Ephemera strigata way back in my school days. I know it is a very short-lived insect; its life spans only a day. However, I never saw such a creature in my life until I collected its fossils.

While we were collecting these "treasures," the locals laughed at us without any reservation. To them, these fossils are just junk they won't bother to pick up.

On our way from DaLian to HangZhou of JeJiang Province, my mind was occupied by what I saw in LiaoXi. A segment of conversation I had had with a local kept popping up: Up to now, how many Psittacosaurus have been unearthed? The answer was more than 5,000, including big ones and babies. How many birds? No less than several thousands! How many insects? It cannot be estimated. Big fish? No one knows. Lycoptera? Don't ask!

A Psittacosaurus nest containing and adult and 34 babies is a rare sight.

"Then, according to your estimation," I asked, "what percent of the land has been explored or excavated?"

"Less than 0.1 percent," came the reply.

Wow! Less than 0.1 percent of the possible area produced such a rich variety and quantity of world-important fossils. If some systematic academic explorations and excavations were done, nobody can guess how many new treasures would come out. I have only one lifetime. Perhaps I need to reincarnate many times to make a tiny scratch on this land.

TenTai, not that far away from HangZhou in eastern JeJiang Province, is one of the major dinosaur egg places. (The other three are Inner Mongolia, AnYang, of HeNan Province, and NanXiong, of GuangDong Province.) Thus, the HangZhou Natural Museum has the geographic advantage. Our friends from the museum told us that, as long as someone from TenTai called them up to inform them about a new house or road construction at a given place, they would drive their truck there

Nobody knows why there are several hundred monster dinosaurs buried along the KunChu Freeway.

A museum considers itself lucky to have just one feathered dinosaur fossil.

and wait to pick up dinosaur eggs! Inside the warehouse of the HangZhou Natural Museum, there are several shelves full of dinosaur eggs, just like those chicken eggs displayed in the supermarket.

Accompanied by dinosaur egg scholar Dr. Jin, we went to TenTai to meet the local TenTai Museum people and survey several places. At one roadside construction place, a nest of dinosaur eggs showed up before our eyes, just sitting among the rubble. "Since this area has so many dinosaur eggs," we asked, "does it ever have any academic study done?"

The TenTai Museum staff asked back, "According to what you just saw, we have eggs everywhere. Can you do any systematic academic study on the site? Can you stop other people from building their house or constructing the road?" Gosh, imagine too many eggs making the excavation difficult.

In the past, some Chinese dinosaur scholars stated that in most of China, if a given place has dinosaur bones, it won't have any eggs, and vice versa. They reasoned that all the "good eggs" were hatched and only the "bad eggs" remained. However, taking the TenTai as an example, this statement must be modified. In the TenTai area, besides numerous eggs, several very interesting dinosaur fossils were found in recent years, especially Segnosaurus. Up to now, all dinosaurs were classified into two main categories: lizard-hip and bird-hip dinosaurs. However, the hip of Segnosaurus is neither like the lizard nor like the bird. It requires a new category. Inside the TenTai Museum, we saw the just-mounted 6-meter-long Segnosaurus. The Chinese Dino King, Prof. ZhiMing Dong, is still looking for its skull. Perhaps the other known Segnosaurus, which is estimated to be about 15 meters long and is still buried, will come with a skull.

Next, our trip took us to the original place of Chinese paleontology, Lufeng, in Yunnan Province. We visited the main dinosaur-producing area, the ChuXiong Prefecture. Several counties in the prefecture from north to south form the main dinosaur belt of Yunnan Province. For the past 60 plus years, several hundred dinosaurs were excavated and more than 10 species were identified. There are about 90 genuses and species of Chinese dinosaurs, covering the late Triassic to early mid-Jurassic.

Take the ChuanJie Dinosaur Graveyard at the southern end of LuFeng County as an example. Nobody knows why there are several hundred monster (10 or more meters) dinosaurs buried along the KunChu Freeway. Could it be that these dinosaurs had an agreement to die together at that spot? Recently, the LuFeng County Dinosaur Museum finished the replication of the biggest dinosaur from China, the 27-meter-long Chuanjiesaurus anaensis. Its shoulder blade is 2 meters long! It went to Japan for exhibit in July 2004.

When my nontalkative American friend, an expert in taphonomy, saw the ChuanJie Dinosaur Graveyard, a gleam of respect showed on his face. We also learned from the ChuXiong Prefecture Museum that in YuanMo County, world famous for early human artifacts, yet another bigger and better dinosaur graveyard was recently found.

On this trip from the northeast to the southwest, I saw and touched many precious Chinese dinosaurs. A person's life is just too short, and what we can study is so limited. In Mainland China, there are so many wonderful dinosaurs awaiting research, and seeing the mainlanders look numbed to the rich dinosaur resources hurts my heart. Who will devote all his or her life to this study? I can be sure it will take more than just one lifetime.

I was lucky enough to be able to prepare a clutch of Troodon eggs from TenTai.

Lucky Strikes *from page 32*

This selenite is from a deposit accidentally exposed by rushing rainwater in a gulch.

The Jacobses didn't own the De Kalk farm, where they lived and where the stone was found. Also living on the De Kalk farm was Schalk van Niewkerk, stepson of the owner. A trader by occupation, he was actually a practicing rockhound, picking up nicely colored stones in his travels. He even owned a book on precious stones, but he had not found any diamonds.

One day, he asked Mrs. Jacobs if she knew of any unusual stones knocking about. She recalled the stone her son had been playing with, and they tracked it down out in the yard. Van Niewkerk thought it might be a diamond, but was not sure. He tested it by scratching a windowpane, which is now in a museum in Colesberg! Still unconvinced, he showed it around, without getting a definite identification. Van Niewkerk gave up and gave the stone to his wife to put in her sewing basket for safekeeping. Eventually, a trader named O'Reilly agreed to take the stone to Assistant Commissioner Lorenzo Boyle in hopes he would confirm it as a diamond. Boyle couldn't do that and showed it to a druggist, who identified it as a topaz! Finally, the stone was shipped off to a Dr. Athertone, who actually tested the gem and proved its authenticity.

The Jacobs gem weighed an impressive 21.5 carats in the rough. It was given the name Eureka and was appraised at about $2,500. When cut, it weighed nearly 11 carats. It is credited with starting the diamond rush in South Africa. Amazingly, the stone went through many hands, including a French consulate, a diamond cutter, and various state officials, before it finally ended up with the crown jewelers in London. After that, it was exhibited in the Paris Exposition in 1867.

Some of the mineral deposits in Mexico have certainly been found accidentally. However, many ore deposits were well known before the Spaniards ever showed up, and no record of these early discoveries exists. One group of mines that were discovered after the Spaniards were driven out are those being worked in the Santa Eulalia region near the capital of the state of Chihuahua. These silver mines were reportedly found accidentally by bandits.

The bandits were not looking for natural riches, but were using the mountains east of Ciudad Chihuahua as a hideout. They would dash out of the mountains and raid travelers on the main highway that ran from El Paso south through Chihuahua. The story goes that one windy night, their cooking fire, which was built against the face of an outcrop, melted a silver-bearing galena vein. The result was the eventual opening of several mines: the Buena Tierra, the El Potosi, the San Antonio Grande, and more.

In the United States, the famous copper mines in the Bisbee area of Arizona came to light when John Dunn and his government scouting party from Camp Bowie were looking for hostile Indians and water. Dunn was in Mule Gulch in the Mule Mountains when he picked up a piece of cerussite, a lead carbonate. He traced the specimen to an outcrop of hematite.

On his way back to Camp Bowie, Dunn came across a prospector named George Warren. As Dunn was associated with the Army, he could not file claims, but Warren could. They agreed that Warren would stake claims in both their names, but he claimed the finds as his own! I think Warren got his comeuppance for acing out Dunn. He lost the Copper Queen claim in a bet that he could outrun someone riding a horse. He lost the race and the millions in copper, gold, silver, lead, and zinc that were eventually mined out of the Queen Mine. The entire mining district, named after George Warren, blossomed forth with a dozen or so rich properties, but Warren actually ended up broke and went to Mexico, where he ended up virtually in bondage for debts.

As an interesting sidelight, the Copper Queen really didn't start paying off until brothers Lewis and Ben Williams went to work there. Lewis built the first smelter, obviating the need to haul ore at immense cost to the coast and shipping it to Wales for smelting. Ben became mine superintendent and successfully managed the property for years. He was also a mineral collector. Ben's collection surfaced in wooden crates only a few years ago and was bought by a mineral and gem dealer. Specimens collected back in the 1880s have now been disbursed into the specimen market. My son Evan was lucky enough to obtain a number of these pieces, along with a cement bust of Ben Williams that was cast for Ben by the local Bisbee Elks organization!

Another story worth repeating happened in Leadville, Colorado, where a huge silver strike was made in a former gold camp. One of the least successful prospectors of the area was H.A.W. Tabor, who finally gave up searching and opened a mercantile store. His wife cooked pies and did laundry. Old Haw, as he was called, grubstaked a couple of boozers to go search for their fortune. The grubstake included a jug of whiskey. The boys hit the trail, but soon decided to sit in the shade of a tree and have a drink or two or three. They then decided the best place to dig for silver was right there in the shade of that tree, so they did. Darned if they didn't accidentally hit a rich silver vein. Tabor was suddenly a rich man! Eventually, Tabor became one of Colorado's richest men, only to end up broke in later years.

Accidental discoveries still happen even in these recent times. For example, two fellows in Coahuila, Mexico, found some red garnets. They showed them to dealer Benny Fenn, who helped them file claims and start mining. You've all seen those delightfully rich red garnets for sale the last decade or so. Imagine what remains to be found in remote regions of the world. I can hardly wait to get to Antarctica! Maybe you'll be walking along one day and will stumble onto something precious or mineralogically interesting. Unlike the people in South Africa, who could not tell a diamond from a topaz, you have knowledge and access to experts who can confirm your good fortune. So good luck and keep your eyes peeled, for that dream has come true again and again. Maybe it'll happen to you one day!